Port Authority Roadway Access Management Guidelines

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THE PORT AUTHORITY OF NY & NJ

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ACKNOWLEDGEMENTS

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CHANGE LOG

Date	**Edit**
January 2016	Updated roadway access classification maps.
January 2016	Updated the definition of access management in accordance with the definition published in the Second Edition of TRB *Access Management Manual*.
January 2016	Inserted *Table 2-4* with references to other Port Authority documents.
November 2017	Updated provisions for pedestrians and bicyclists.

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PREAMBLE

Need for Roadway Access Management at Port Authority Facilities

The safe and efficient movement of people and goods at Port Authority facilities is critically important to the continued success and vitality of the Port Authority. Delays resulting from traffic congestion and crashes along Port Authority roadways increase both travel times and business costs for all users of these roadways, thereby undermining the operational efficiency of Port Authority facilities. Proper planning, design, and coordination help minimize such delays by promoting a safe and streamlined traveling environment, which helps to increase operational efficiency, maximize revenues, and reduce costs, liability, and crashes wherever operationally and financially feasible.

Many transportation agencies have recognized a need for increased *roadway access management* in response to these challenges. The purpose of roadway access management is to provide access to land development in a manner that preserves the safety and efficiency of the transportation system. As noted in the *Access Management Manual, Second Edition*, access management is defined as:

> *The coordinated planning, regulation, and design of access between roadways and land development. It involves the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway, as well as roadway design applications that affect access, such as median treatments and auxiliary lanes, and the appropriate separation of traffic signals*.[1]

One of the initiatives of the Chief Engineer is to develop an access management program for Port Authority facilities. To that end, these *Roadway Access Management Guidelines* were prepared to help incorporate access management concepts and methods into the agency's business practices in recognition of the agency's – and the region's – economic reliance on the efficient operation of Port Authority facilities. These *Guidelines* are consistent with the agency's Mission Statement:

> *To enhance the region's competitiveness and prosperity by providing transportation services that efficiently move people and goods within the region and facilitate access to the nation and the world.*

Access management has many dimensions at the Port Authority. It crosses organizational lines throughout the agency and involves staff from the line departments, Real Estate Services Department, Traffic Engineering, and other groups. It also affects consultants working on Port Authority projects, as well as tenants conducting day-to-day business on Port Authority property. Each of these groups has an important role in determining access outcomes and shaping the future vision for Port Authority facilities, whether through a lease negotiation with a tenant, the Tenant Construction and Alteration Process (TCAP), or a roadway improvement project initiated by the agency.

Because access management is multi-disciplinary and may influence the decisions of various individuals and groups, both within and outside of the Port Authority, it requires partnerships within the agency and a greater awareness of how the decisions of one group affect others. These individuals and groups must collaborate – both internally and externally – to manage access effectively and address potential problems proactively, preventing them from materializing later and, thereby, ensuring successful project outcomes.

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[1] *Access Management Manual, Second Edition*, Transportation Research Board, National Research Council, Washington D.C., 2014, p. 521.

Purpose of these Guidelines

Development activities and transportation improvement projects at Port Authority facilities often involve balancing traffic operations and safety with the needs of tenants. Access management provides the quantitative tools to successfully achieve this balance. In addition to providing detailed technical guidance, this document is intended to create synergy and promote successful project outcomes by providing an informed and structured approach to decision-making for use by and among the various organizational entities within the Port Authority. It is also intended to streamline the development process for tenants and their consultants by communicating the Port Authority's access management guidance, thereby improving the predictability of the development process and reducing the likelihood of tenant document revisions.

Because access management practices in the United States have been evolving based on research conducted over the past few decades, the concepts and methods set forth in this document represent the most recent research at a national level. This includes research published in the TRB *Access Management Manual*, as well as subsequent research efforts. Due to this evolution, some of the specific technical elements presented here may lead to different designs or decisions than previous experience would otherwise suggest. In all cases, however, this document tailors current national access management practices and strategies to specific applications at Port Authority facilities, while providing the Port Authority with an appropriate degree of flexibility needed both to accomplish its operational objectives and to accommodate future growth in a safe, efficient, and environmentally-sensitive manner.

Contents and Organization of these Guidelines

These *Roadway Access Management Guidelines* provide both general guidance for all Port Authority staff and detailed technical guidance for planning and engineering professionals. This includes Port Authority staff involved with TAA reviews, design of improvement projects, and day-to-day operations, as well as consultant engineering staff hired by tenants to prepare TAA design packages. This document was prepared to reflect the fact that its users have diverse backgrounds with a range of familiarity with access management principles, concepts, and techniques. For this reason, the specific technical guidelines presented in each chapter are preceded with an overview that provides background information, introduces basic concepts, and provides an educational framework for the technical guidelines that follow. This document provides:

1) An introduction to access management, including objectives, principles, and benefits;
2) A discussion of the role of access management in Port Authority business practices;
3) A description, and associated maps, of the roadway access classification system that has been established for Port Authority facilities;
4) Detailed engineering design guidance for the following areas:
   - Roadway cross-sectional elements
   - Unsignalized driveway spacing
   - Intersection corner clearance (spacing of driveways from intersections)
   - Traffic signal spacing
   - Access in the vicinity of interchanges
   - Driveway design

- Roadside buffers
- Intersection sight distance
- Auxiliary lanes, including exclusive left-turn and right-turn lanes

For each of the bulleted items above, the guidelines in the following chapters provide both Desirable and Minimum numerical values. The user is expected to meet or exceed the Desirable values. Where the user wants to use any value less than the Desirable value, a design exception is needed from the Chief Engineer for the applicable discipline. (See *Table 2-1* for the proper Port Authority point-of-contact within the Engineering Department.)

5) A discussion of property access strategies and access management efficacy; and
6) General approval criteria and procedures for design exceptions when there is a perceived need to deviate from the established engineering design guidance described in this document, as indicated by the use of the verb "should."

Key words to apply these Guidelines

In these *Guidelines* the following terms are used:

- "Shall" – indicates a required or mandatory action.
- "Should" – indicates guidance of recommended practice, with deviations allowed by the Chief Engineer of the relevant discipline, using the design exception procedure.
- "May" – indicates a statement of practice that is a permissive condition.

Future Editions

This document is intended to be a "living document." As such, it will be revised periodically by the Port Authority to reflect new research and lessons learned through the course of its application.

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CHAPTER 1: INTRODUCTION TO ROADWAY ACCESS MANAGEMENT

1.1 What is Roadway Access Management?

Roadway access management is defined as:

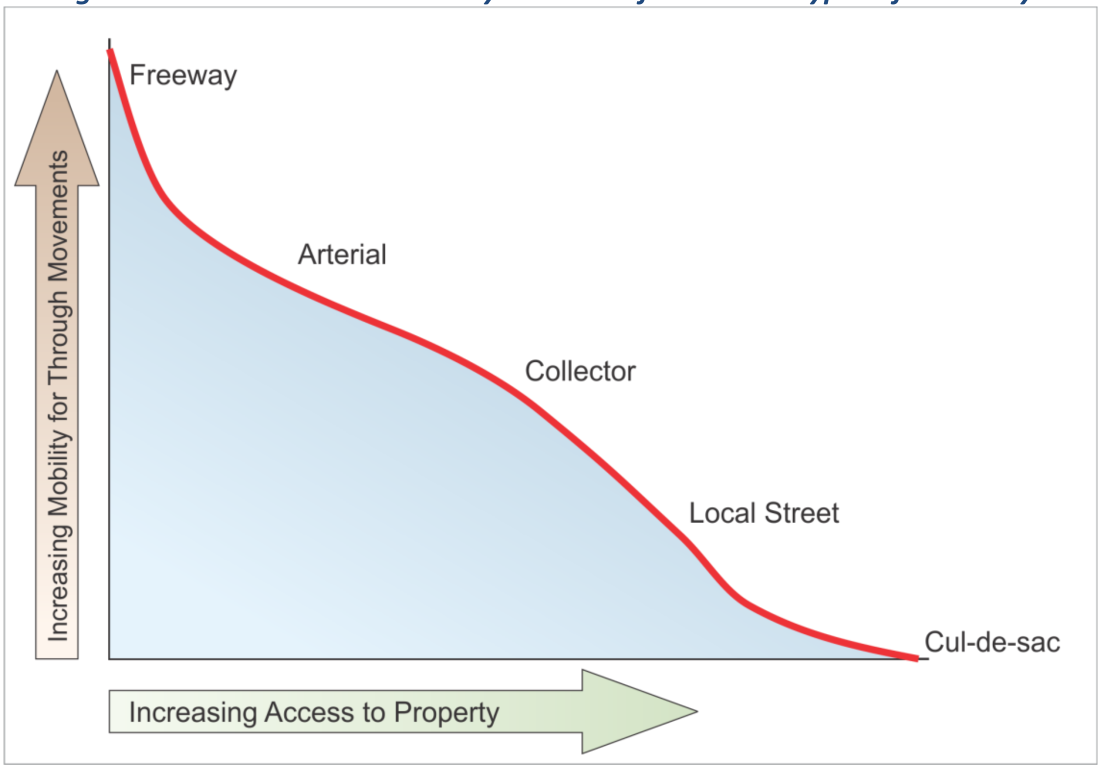
> *…the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway. It also involves roadway design applications, such as median treatments and auxiliary lanes, and the appropriate spacing of traffic signals.*[2]

The purpose of roadway access management is to provide access to land development in a manner that preserves the safety and efficiency of the transportation system. The contemporary practice of access management extends the concept of access design and location to all roadways – not just limited-access highways or freeways.

Contemporary access management is a systematic way to implement the roadway functional hierarchy that is implicit in the structure of most surface transportation networks serving large areas of developed or developable land. As part of access management, roadways are classified by function on the basis of the priority given to land access versus through-traffic movement (see *Figure 1-1*).

As *Figure 1-1* shows, each roadway classification has a unique mix of mobility function and access function. At one end of the spectrum are freeways, which represent the highest classification of roadways in the transportation network. Freeways primarily serve a through-traffic mobility function and have the lowest property access function because access is typically limited to grade-separated interchanges with other freeways, arterials, and other higher classification roadways.

Figure 1-1: Access versus Mobility Functions for Various Types of Roadways



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[2] Source: *Access Management Manual, First Edition*, Transportation Research Board, National Research Council, Washington D.C., *2003*.

At the other end of the spectrum are cul-de-sacs, which represent the lowest classification of roadways in the transportation network. Cul-de-sacs primarily exist to serve a direct property access function (to abutting residences or businesses) and – by virtue of their dead-end nature – accommodate no through traffic mobility function.

In between these two extremes (i.e., freeway and cul-de-sacs) are arterials, collectors, and local roads. These roadways serve both mobility and access functions, but in varying degrees as shown in *Figure 1-1*. Limiting access along arterials and other primary roads is extremely important. Drivers on these roads anticipate moving quickly with little or no congestion. Although these roadways may also need to accommodate access to adjacent properties, numerous closely-spaced driveways can result in traffic congestion and collisions. Access management is also necessary on lower-level roadways including collectors and local streets, where the roadway's mobility function is less important than on an arterial, but a greater degree of property access is required.

It is important to understand that the degree of access management varies not only with the functions and traffic characteristics of a roadway, but also with the character of the abutting land and the long-term planning objectives. More restrictive access management standards may be desirable on one arterial roadway, and less restrictive standards may be more appropriate on another. In addition, some major roadways may serve a mix of competing functions that are difficult to reconcile and that may require special design treatments or access management measures.

1.2 Access Management Objectives

To achieve the broad goal of accommodating access safely and efficiently, the Port Authority seeks to manage the location, design, and type of property access from its roadway facilities. Specific objectives of this effort include the following:

- Reduce traffic congestion
- Maintain traffic flow
- Reduce frequency and severity of crashes
- Reduce fuel consumption and vehicle emissions
- Preserve existing roadway capacity
- Accommodate pedestrians, bicyclists, and transit vehicles
- Support economic growth
- Provide access to businesses and tenant leaseholds
- Maintain or improve property values
- Preserve the Port Authority's investment in its transportation infrastructure

The key to achieving the Port Authority's objectives is the application of the following access management techniques, which are fully described in the subsequent chapters of these *Guidelines*:

- Consolidate and limit (where necessary) access along the Port Authority roadway system
- Promote development of an interconnected roadway system
- Promote sharing of property access to the roadway system

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- Promote efficient circulation in Port Authority facilities

The primary goal is to create a system of interconnected roadways at each Port Authority facility that functions safely and efficiently for its useful life. Additionally, proper application of access management techniques helps promote safe and convenient access to land uses for businesses and travelers as well as more cost-efficiency in the Port Authority use of roadway funds.

1.3 Basic Access Management Principles

The application of basic access management principles can accomplish the objectives listed above. These principles are founded on an understanding of the different needs of the drivers using the roadway network, knowledge of which roadway elements cause the greatest conflicts, appreciation of the concerns of tenants and the Port Authority, and expertise in applying traffic engineering/access management techniques to these, at times, contradictory desires. Basic access management principles include the following:

1.3.1 Develop a Specialized Roadway Access Classification System

Because different types of roadways serve different functions relative to access and mobility, as described above, it is important to design and manage roadways according to their primary functions. In this way, proper balance can be achieved between traffic flow and access to abutting property, improving roadway operations.

1.3.2 Limit Direct Access to Major Roadways

Roadways that serve high volumes of through traffic, such as freeways and arterials, need a high level of access management to preserve their traffic movement function. On the other hand, frequent and direct property access is more compatible with the function of local and collector roadways. The underlying principle here is that direct access to a major roadway is not required when other access options are available.

1.3.3 Promote Roadway and Intersection Hierarchy

An efficient transportation network provides appropriate transitions from one classification of roadway to another. For example, freeways connect to arterials through an interchange that is designed appropriately for the transition. This concept also extends to surface streets, resulting in a series of intersection types that range from the junction of two principal arterial roadways to a tenant driveway connecting to a local street. The more important the mobility function of the roadway (i.e., the higher its classification), the higher the degree of access management that should be applied so that the roadway continues to perform according to its designed function.

1.3.4 Locate Signals in Accordance with Desired Signal Control Strategies

Along roadways where the progression of through traffic is the prevailing signal control strategy, long, uniform spacing of intersections and signals enhances the ability to coordinate signals and enables the continuous movement of traffic at the desired speed. Establishing a minimum bandwidth at coordinated traffic signals along a roadway helps to provide an orderly progression of through traffic from one intersection to the next. On the other hand, poor signal placement may lead to delays that cannot be overcome by signal timing or phasing changes. In addition, failure to carefully locate access connections or median openings that may later become signalized can cause substantial increases in arterial travel times.

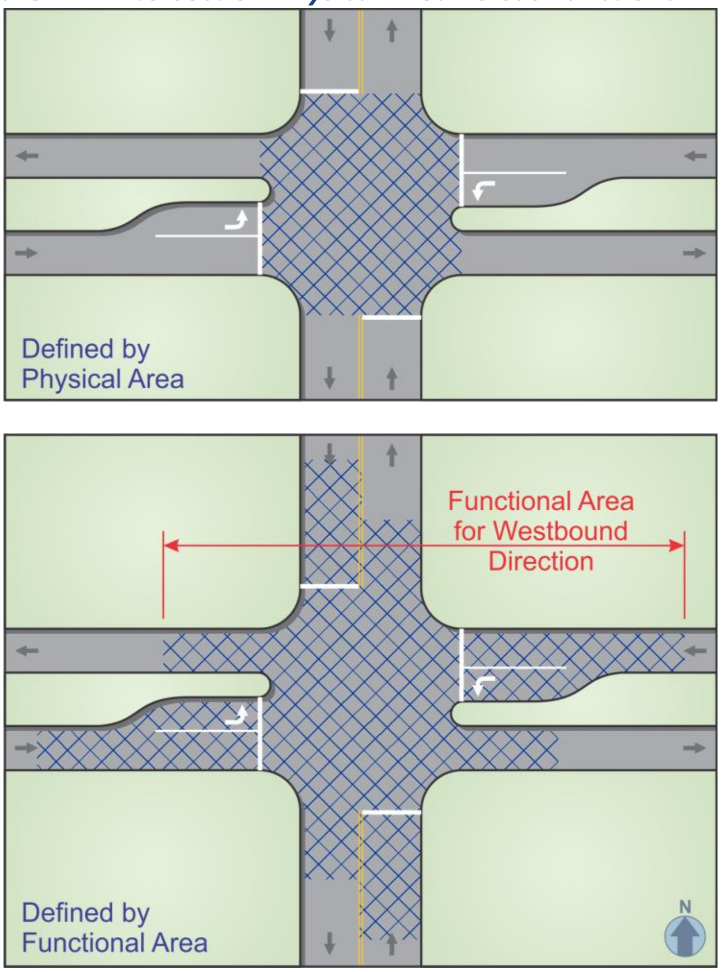
In cases where roadways already have existing traffic signals spaced relatively close to one another, the prevailing signal control strategy may be to manage the signal timing and phasing sequences so that vehicle queues do not spill back from one intersection to the next, obstructing the movement of traffic. Requests for new traffic signals under these circumstances must be analyzed considering this control strategy.

In yet another circumstance, the prevailing signal control strategy may be to accommodate high volumes of pedestrian movements – for example, across an airport terminal frontage roadway to an adjacent parking garage. In this situation, traffic signals must be located and operated with the priority given to the movement of pedestrians rather than the progression of through traffic.

1.3.5 Preserve the Functional Area of Intersections

To maximize the safe and efficient operation of an intersection, it is essential to preserve its functional area. The functional area extends beyond the physical junction of the intersecting roadways (see *Figure 1-2*). This functional area includes the approaches and vehicle departure areas where motorists are responding to the traffic control devices at the intersection by accelerating, decelerating, and maneuvering into the appropriate lane to stop or complete a turn. Access driveways located within these functional areas can cause motorist confusion and traffic conflicts that impair the function of the intersecting roadways.

Figure 1-2: Intersection Physical Area versus Functional Area



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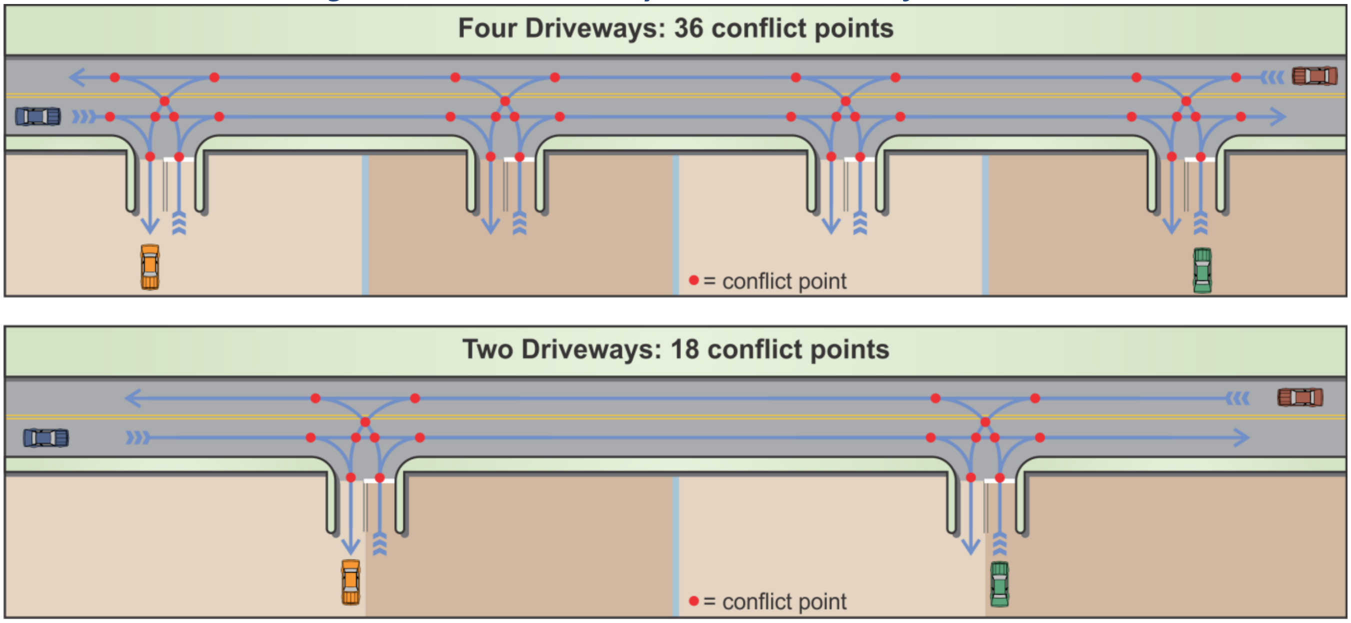
1.3.6 Limit the Number of Driveways and Other Conflict Points

Drivers make more mistakes and are more likely to have collisions when they are presented with complex driving situations created by numerous conflicts. Simplifying the driving task, by limiting the number of driveways along a roadway – and the associated conflict points facing a motorist – contributes to improved traffic operations and fewer collisions. As shown in *Figure 1-3*, the roadway segment with four driveways has twice as many potential conflict points as the same roadway segment with only two driveways.

Figure 1-3: More Driveways Means More Conflict Points



Furthermore, the number of potential conflicts increases substantially when pedestrian and bicycle movements are considered as well. Therefore, a less complex driving environment is accomplished by limiting the number of driveways and the resultant number of conflict points between vehicles, vehicles and pedestrians, and vehicles and bicyclists.

1.3.7 Separate Driveways and Other Conflict Points

Drivers need sufficient time to address one set of conflicts before facing another. Thus, to provide drivers adequate perception and reaction time, the necessary spacing between conflict areas must increase as travel speeds increase. Separating conflict areas helps to simplify the driving task and contributes to improved traffic operations and lower crash frequency.

1.3.8 Remove Turning Vehicles from Through Traffic Lanes

Left-turn and right-turn lanes allow drivers to decelerate gradually out of the through lane and wait in a protected area for an opportunity to complete a turn, thereby reducing the severity and duration of conflicts between turning vehicles and through traffic. Similarly, adequate deceleration distances allow drivers to transition their travel speeds gradually when leaving the through traffic stream. The separation of turning and through traffic reduces crash frequency and improves efficiency.

1.3.9 Use Non-Traversable Medians to Manage Left-Turn Movements

Non-traversable medians channel left-turn turning movements to designated locations. Non-traversable medians that minimize left-turns or reduce the driver workload can be especially effective in reducing crash frequency. As shown in *Figure 1-4*, the four-leg intersection with all traffic movements allowed results in a total of 36 conflict points associated with the various crossing, merging, or diverging movements. On the other hand, as shown in *Figure 1-5*, a three-leg intersection with a non-traversable median limits the number of conflict points to only six when left-turns are allowed from the roadway to the driveway via a median opening and only two points when no left-turns are allowed (no median opening). Non-traversable medians also eliminate head-on collisions between traffic moving in opposite directions along a roadway. Full median openings – allowing left-turns from either direction on all approaches – must be analyzed on a case-by-case basis.

Figure 1-4: Conflicts at Four-Leg Full-Movement Intersection

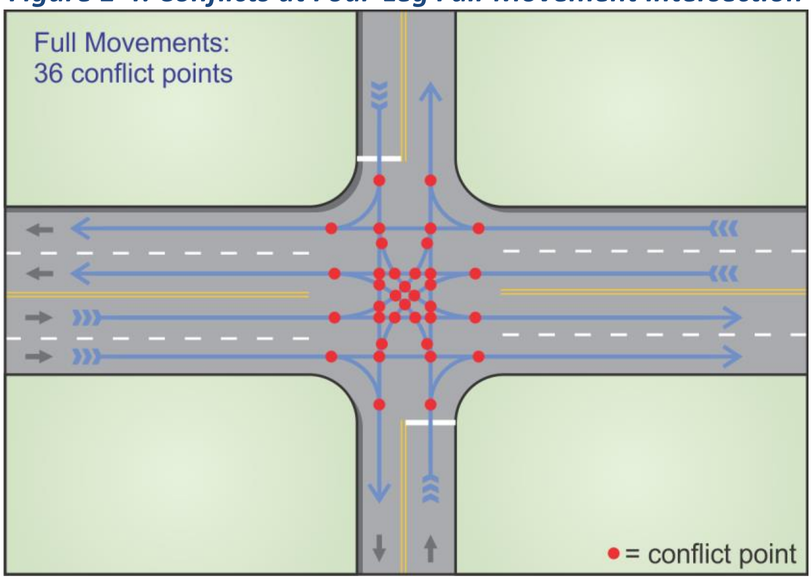
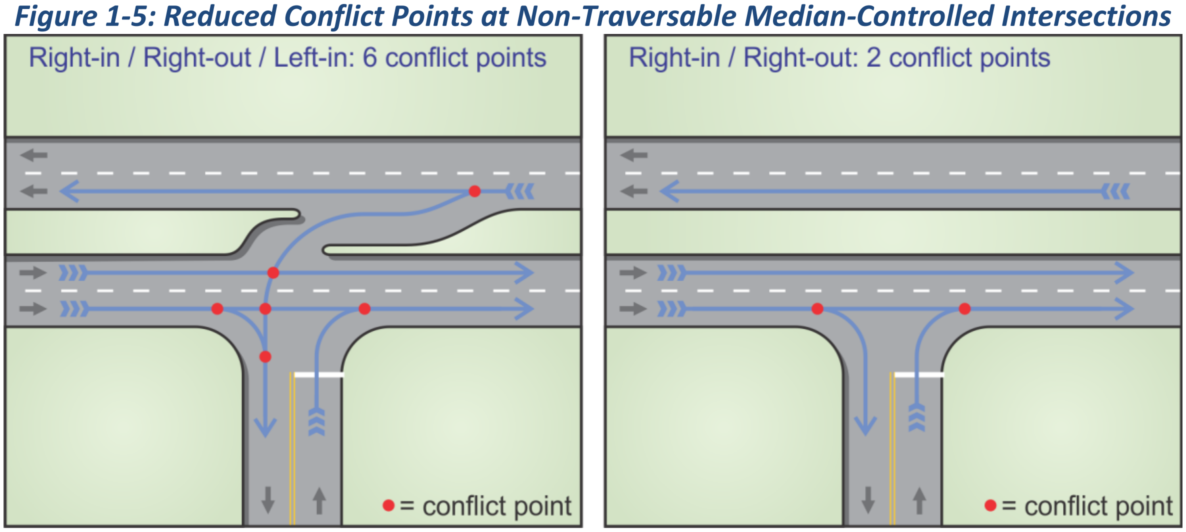


Figure 1-5: Reduced Conflict Points at Non-Traversable Median-Controlled Intersections



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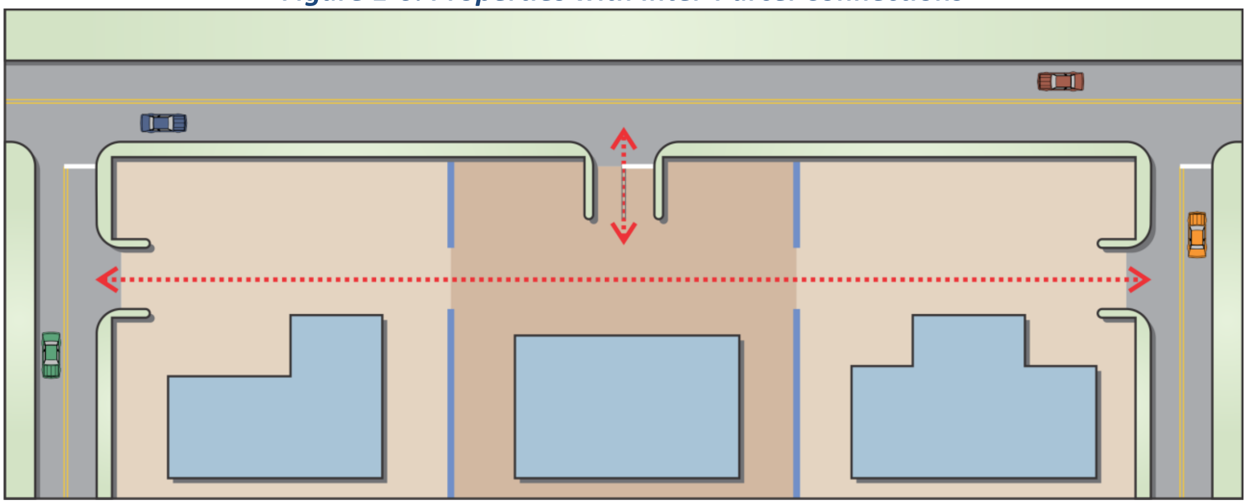
1.3.10 Provide a Supporting Street System and On-Site Circulation Systems

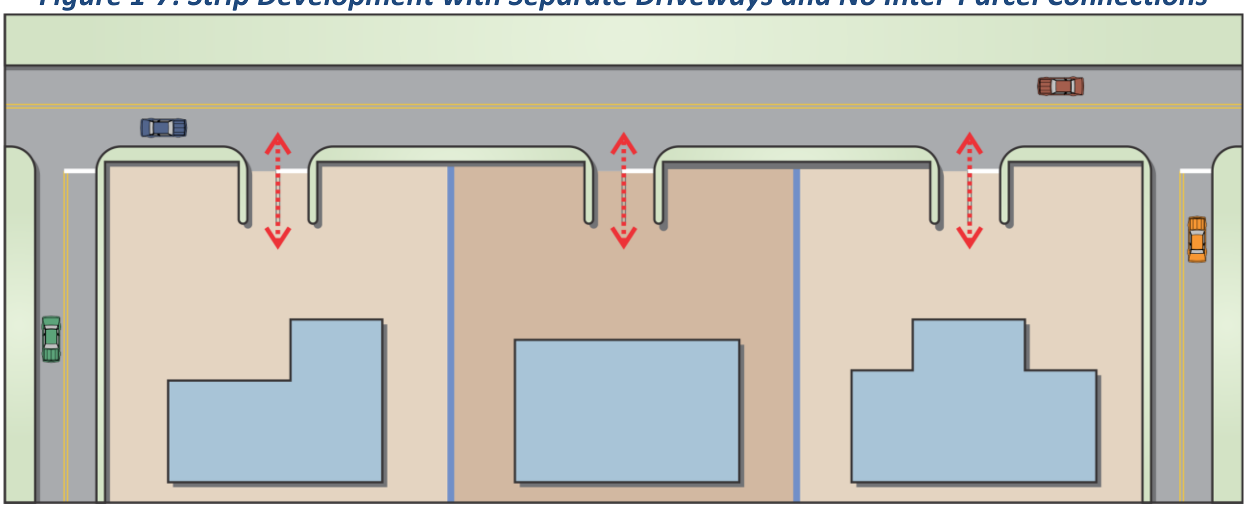
Access connections between adjacent parcels or leaseholds – as well as an interconnected network of supporting roadways – are beneficial in maintaining efficient traffic flow. A well-planned transportation system provides a supporting network of streets and direct inter-parcel connections (see *Figure 1-6*) to accommodate future development or redevelopment. Interconnected roadway networks and on-site circulation systems provide routes for motorists, pedestrians, and bicyclists that are alternatives to using the primary roadways.

Figure 1-6: Properties with Inter-Parcel Connections



Conversely, "strip development" (see *Figure 1-7*) with separate driveways for each business creates very short distances between access points on the roadway, impeding mobility and increasing crash frequency along that roadway.

Figure 1-7: Strip Development with Separate Driveways and No Inter-Parcel Connections



1.3.11 Match Driveway Design with Operational Needs

Driveways accommodate a wide range of vehicle types, traffic volumes, and vehicle turning speeds. For example, a short curb-return radius cannot efficiently accommodate the large trucks or the high-speed traffic expected on an arterial, but it may be an acceptable design treatment in lower-speed areas where only passenger cars and single-unit trucks are expected, or where there is a desire to shorten the pedestrian crossing distance. Consequently, driveway design should be tailored to meet the needs of all users of the driveway, considering trade-offs in the design features related to motorists, pedestrians, and bicyclists.

1.4 General Strategies for Implementing Access Management

Because independent implementation of access management by one person or group is impossible to achieve, coordination and collaboration are essential. Effective access management is never accomplished by one person or group independently. To optimize the benefits of access management, coordination and cooperation with appropriate stakeholders (including Port Authority staff, tenants and leaseholders, and consultants) is essential when initiating planning for a TAA project or undertaking a new roadway improvement. In addition, intra-agency coordination is critical when applying access management standards relative to a lease negotiation.

The effective application of access management is also greatly enhanced by on-going education and training activities to inform consultants, tenants, and staff from throughout the agency about the benefits of access management, the principles and techniques for successful application, and implementation activities.

Furthermore, the benefits of access management are realized most effectively when the techniques and strategies are considered early in the conceptual planning stages of a project, before key decisions about roadway alignments, building locations, access locations, and other aspects of a project are made. Once these key decisions are made, and a project has advanced beyond the planning stage (e.g., into design), it is more costly, time-consuming, and disruptive for everyone involved to go back and revise plans to incorporate recommended changes. Even worse, once a project is constructed, the costs to reconstruct a site or retrofit a roadway to make improvements in response to safety or operational issues that materialize after construction are quite often prohibitive.

1.5 Benefits of Access Management

Roadways are an important resource, costly to build, to maintain, to improve, and to replace. Because of this, it is simply not practical to allow roadways to deteriorate due to poor access management under the assumption that they will be replaced or reconstructed in the future. This is why effective management of the transportation system is essential.

By managing roadway access, the Port Authority can extend the life of its roadways, improve public safety, reduce traffic congestion, and improve the appearance and quality of its built environment. Access management not only preserves the transportation functions of roadways but also helps preserve long-term property value and the economic viability of abutting development. From an environmental perspective, improved traffic flow translates into greater fuel efficiency, reduced vehicular emissions, and a smaller carbon footprint.

Proper access management practices at Port Authority facilities will benefit many groups in several different ways. These include the following:

- The **Port Authority** benefits from a lower cost of delivering an efficient and safe transportation system, greater effectiveness in accomplishing transportation objectives, and reduced capital improvement costs associated with new or reconstructed roadways;
- **Tenants** are served by a more efficient roadway system that captures a broader market area, and they also benefit from stable property values due to a well-managed roadway network. In addition, they experience a more predictable and consistent development environment;
- **Freight carriers** benefit from reduced delay and crash frequency, resulting in lower transportation costs and shorter delivery times;

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- **Motorists** face fewer decision points and traffic conflicts, simplifying the driving task, lessening congestion, and reducing crash frequency;
- **Pedestrians and cyclists** deal with fewer conflicts where motorists access the roadway, thereby improving the environment for walking and bicycling; and
- **Transit riders** experience reduced delay and reduced travel times.

Considerable research and experience from around the United States over the last several decades has demonstrated the traffic safety and operational benefits of access management. The benefits, however, extend beyond those to also include economic, environmental, system preservation, and aesthetic benefits. Results of national research are summarized in both the *Access Management Manual* and *NCHRP Report 420: Impacts of Access Management Techniques*.

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CHAPTER 2: THE ROLE OF ROADWAY ACCESS MANAGEMENT IN PORT AUTHORITY BUSINESS PRACTICES

2.1 Overview of the Port Authority

The Port Authority plans, builds, operates, and maintains infrastructure critical to the New York / New Jersey region's trade and transportation network. These facilities include the nation's busiest airport system, marine terminals and ports, the Port Authority Trans-Hudson (PATH) rail transit system, six tunnels and bridges between New York and New Jersey, the Port Authority Bus Terminal in Manhattan, and the World Trade Center. Providing ingress to, egress from, and circulation within each facility is an extensive and complex roadway network, for which the Port Authority is also responsible. For more than eight decades, the Port Authority has worked to improve the quality of life for the more than 17 million people who live and work in New York and New Jersey.[3]

The agency's area of jurisdiction is called the Port District, a region within a radius of approximately 25 miles from the Statue of Liberty. The Port Authority was created to promote and protect the commerce of the Port District and to undertake port and regional improvements not likely to be financed by private enterprise, or that would not be attempted by either State alone. These include the development of major infrastructure: a modern port for the harbor shared by the two states, tunnel and bridge connections between the states, and, in general, trade and transportation projects that secure the region's economic well-being. The Port Authority's goal, as articulated in its mission statement, is "…to enhance the region's competitiveness and prosperity by providing transportation services that efficiently move people and goods within the region and facilitate access to the nation and the world."

2.2 Tenant Transportation and Access Needs at Port Authority Facilities

To help achieve the goals and objectives of its mission, the Port Authority leases portions of its property to tenants at the agency's various port and airport facilities. At port facilities, tenants typically move and store containers and large pieces of equipment, as well as process and move goods to, from, and within their leaseholds. The agency's airport facilities include airline, delivery service, and rental car tenants, and accommodate the movement of aircraft, allow for customer arrivals and departures, and provide adequate parking. These tenants are critical revenue-generating customers for the Port Authority.

Tenant activities and land uses also generate transportation needs and demands that must be accommodated. Both port and airport facilities must provide transportation infrastructure to meet the travel demands generated by tenants and customers who may choose to drive, walk, use public transportation, bicycle, or be dropped-off.

Furthermore, the need for access to and from specific tenant leaseholds must be balanced with the need for mobility for all users of the transportation network within a given Port Authority facility. At each facility, there are competing needs for space among various transportation modes and vehicle types: passenger cars, trucks, pedestrians, transit vehicles, and bicyclists. Most, if not all, of these user groups and vehicle types must be accommodated within the available right-of-way on many Port Authority roadways.

[3] Source: Port Authority website, February 15, 2012: http://www.panynj.gov/about/facilities-services.html

2.3 Importance of Roadway Access Management at Port Authority Facilities

Given the intensity of the activity at Port Authority facilities, the land use, property access, and mobility needs at any given facility are often in competition and, thus, need to be balanced. Sometimes this balance is not what it should be. For example:

- Improperly placed storage containers and poorly-located fences may obstruct sight distances for motorists attempting to exit a driveway, causing traffic safety and operational problems;
- A high volume of delivery trucks turning into a warehouse may generate traffic delays and congestion on a Port Authority roadway. The poor operations may result in crashes, generating even more delay and congestion for all users of the roadway;
- Airline passengers driving to an unfamiliar airport may be distracted or rushed and, therefore, may not be able to identify a parking facility entrance in time to make a turn, increasing the potential for a crash. Enhancements in design may alleviate this.

Within this context, access management provides the Port Authority with a tool to intelligently balance the competing needs that exist on the agency's real estate. Consistent application of this tool helps meet the interests of the agency, as well as those of its tenants and stakeholders. The access management guidelines presented in this document describe how to achieve this balance in a rational, safe, and efficient manner. The implementation of access management will allow the Port Authority to improve the safety and efficiency of the transportation networks at its facilities and also help the agency remain competitive with similar facilities in other areas of the country. Access management principles are also consistent with the Port Authority's mission statement, noted previously.

Over the last 50 years, the transportation research community has consistently found that when development patterns follow access management principles, the resulting transportation operations are safer and more efficient, among other benefits. Recognizing these benefits, many state departments of transportation – led by those in Colorado, Florida, Oregon, and New Jersey in the 1980s and early 1990s – began to adopt and formally incorporate access management into their respective agency's procedures. A national Access Management Committee was formed by the Transportation Research Board (TRB) in the early 1990s, which has since sponsored many research projects on a variety of access management topics. In 2003, the TRB Committee developed and published the first edition of the *Access Management Manual*, with an updated second edition following in 2014. Based on the research findings and practical "lessons learned" as documented in the *Manual* – as well as those resulting from on-going research – other state DOTs and transportation agencies throughout the nation are continuing to implement their own access management guidelines.

Today, every state department of transportation – and many local transportation agencies – has procedures in place for regulating where points of access should be allowed and guidelines for how they should be designed. The Port Authority's efforts are consistent with the actions of state DOTs and other agencies.

The implementation of access management guidelines is expected to result in the following benefits to the Port Authority:

- **Improved Safety** – The proper location and design of access points on Port Authority roadways, in accordance with access management principles, reduce the probability of crashes.
- **Enhanced Traffic Operations** – Access management results in more efficient traffic flow and reduced delays, improving the movement of people and goods as well as enhancing customer service – all of which are important to the Port Authority and its tenants.

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- **Streamlined Business Operations** – All businesses are concerned with their own financial bottom line, which is based in part on how quickly and efficiently they can move their goods and satisfy the needs of their customers. Access management allows the Port Authority to help tenants to accomplish those goals.
- **Preserved Value of Port Authority's Investment in the Transportation System** – Access management helps maximize the value of capital improvements constructed by the Port Authority at its facilities by minimizing the probability that they might be needlessly consumed and degraded over time by inefficient operations. This enables the agency to maximize the value from its investment in the transportation system.
- **Reduced Environmental Impacts** – The traffic operational benefits of access management also help reduce vehicular emissions and pollution, reduce fuel consumption, and promote energy efficiency and sustainability. These actions help the agency move toward its carbon neutrality goals.

2.4 Overview of Implementing Roadway Access Management at Port Authority Facilities

Implementing roadway access management at the Port Authority involves: a) coordinating with Port Authority Engineering, b) including access management in the transportation planning process (i.e., preparation of transportation master plans, sub-area plans, and/or other transportation studies), and c) application of the technical guidelines contained in this document to projects at Port Authority facilities. Each of these implementation components is described below.

2.5 Involving Port Authority Engineering Department in Early Stages

To implement access management successfully at the Port Authority, coordination with and involvement from Port Authority Engineering – in the early stages of leasehold negotiations, roadway improvement projects, and TAA planning and design activities are required.

Access management needs to be considered *throughout* project planning, design, and construction. Furthermore, it is important to underscore the involvement of Port Authority Engineering in the *early* stages of project planning. Solutions to potential access management related problems are best achieved in the preliminary stages of project planning, before building locations and roadway layouts have been established. In this regard, tenants and consultants shall coordinate their efforts with Port Authority Engineering in accordance with the provisions of this chapter. This coordination is initiated at project inception when design alternatives are being evaluated at the preliminary/conceptual design stage (i.e., the "tissue paper" stage). Postponing or ignoring access management considerations until a TAA is submitted or design documents are produced, when considerable time and money have already been spent and decisions have been made that affect the work of other groups within the agency, often makes the best solutions difficult or impossible to achieve.

Proactive planning for projects at Port Authority facilities is intended to avoid traffic safety and operations problems that materialize slowly over time. Often, when traffic volumes and development densities are low, these problems are not readily apparent. But as traffic volumes and development densities increase, these problems manifest themselves in the form of traffic congestion and high-crash locations. Yet it often becomes very difficult and expensive to make improvements to solve those problems without significant and costly disruptions to tenants. The necessary improvements may require working around or demolishing existing buildings, displacing tenants, and diverting and protecting high volumes of traffic. All of these actions add to the cost and complexity of any improvement proposal brought forward to solve the traffic safety and operational issues that have materialized due to the poor planning and design choices made in the early stages of project development.

In addition, the lack of proactive access management could subject the Port Authority to added costs and liabilities. The timeline in *Figure 2-1* illustrates one possible sequence of events for a site development project at a Port Authority facility where access management is *not* a consideration. As shown in the timeline, access management considerations do not play any role in the early stages of project development (i.e., the expression of interest), nor in the planning or project design stages (i.e., subdividing the site, establishing the access provisions, negotiating and executing the lease agreement). Only once the site is occupied are problems identified, usually after a period during which poor operations are observed and recognized over time. Furthermore, these poor operations continue while a solution is designed (at additional cost) and remain until that solution can be implemented (again, at additional cost). As shown in *Figure 2-1*, the Port Authority is also susceptible to increased liability during this period of poor operation, which could last for years. In addition, the "best" solution may not ultimately be achievable based on a variety of constraints, as described above. Therefore, some traffic safety and operational problems might remain even after the "corrective action" is taken.

In contrast, *Figure 2-2* illustrates the same site development project under a scenario where proper access management planning begins in the early stages of project development (i.e., at the expression of interest stage). These efforts continue through the planning stage – when subdivision of the property and lease negotiations take place – as well as through the design and build stages. As shown in *Figure 2-2*, the net result is desirable traffic operations and safety from the time the site is first occupied. In addition, due to the early involvement of Port Authority Engineering and application of roadway access management guidelines, the best solution can most likely be achieved right from the start. Furthermore, the Port Authority saves the added costs associated with designing and building "fixes" to problems and avoids the time period of poor operations and safety – and associated cost and liability – illustrated in *Figure 2-1*.

Therefore, roadway access management needs to be considered in the early stages of project planning and throughout project design and construction. Port Authority Engineering should be involved from the expression of interest stage and continue to be involved when the site is being developed (including the determination of lease boundaries), access provisions are being established, the lease agreement is being negotiated and executed, and the project is being designed and constructed.

Furthermore, the following project types shall involve coordination with Port Authority Engineering and the application of the guidelines contained in this document:

1) Preparation of a TAA as part of the Tenant Construction and Alteration Process (TCAP)
2) Lease renewal for properties with vehicular access to a Port Authority roadway
3) Roadway improvement projects initiated by the Port Authority

The intent, for all project types, is to streamline decision-making within the Port Authority, build consensus from among various stakeholder interests, and resolve potential issues proactively, before they become problematic. Proper implementation will result in savings in time, money, and liability to the agency, as well as the aforementioned benefits with respect to crash rate reduction, traffic operations, business operations, capital investments, and the environment.

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Figure 2-1: Project Development Timeline without Consideration of Access Management

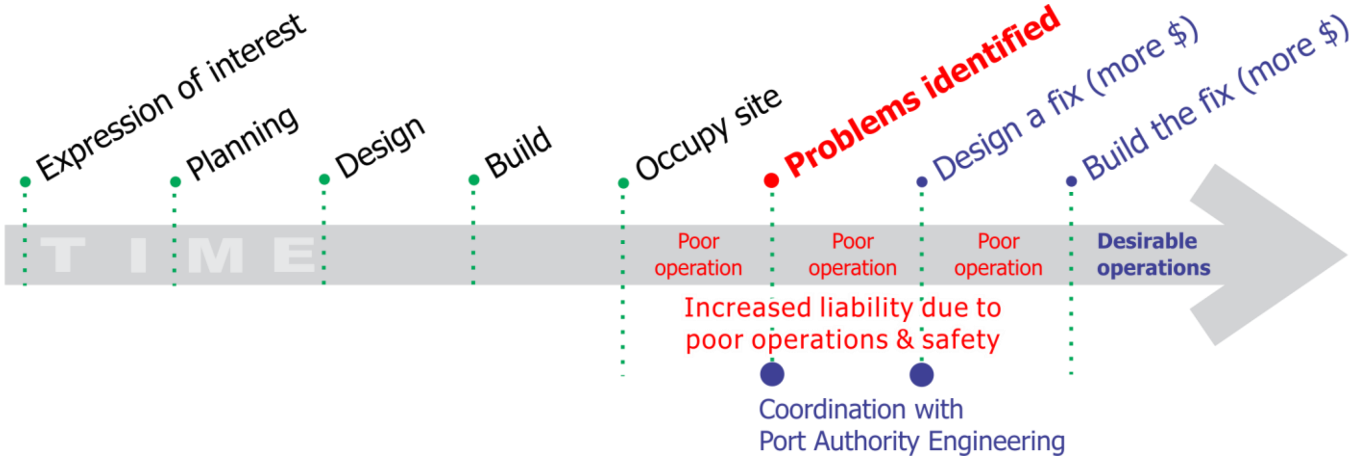
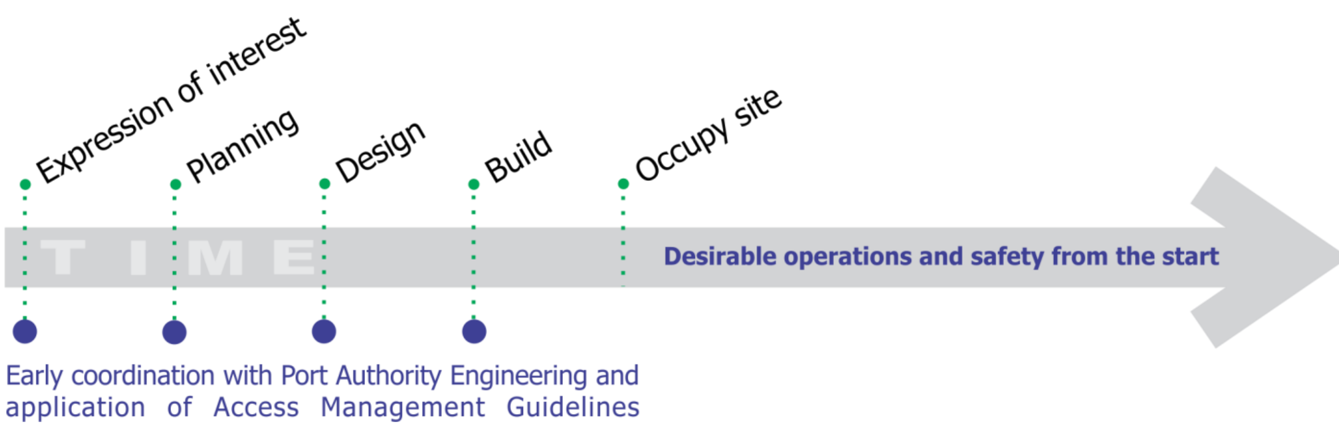


Figure 2-2: Ideal Project Development Timeline that Considers Access Management



As described above, coordination – early and often – with Port Authority Engineering is key in realizing the most successful project outcomes. It is important that proper channels of communication be followed when a tenant, or tenant design team, is communicating with the Port Authority. *Table 2-1* shows the proper points-of-contact for initiating communication with the Port Authority for various project types.

Table 2-1: Initial Points-of-Contact for Coordination with Port Authority

Project Type	Facilitator for Team Conceptual Planning Meeting	Contact within Engineering Department
Tenant Alteration Application (TAA)	Quality Assurance Division (QAD) of the Engineering Department	QAD
New Lease or Lease Renewal Negotiations	QAD	QAD
Port Authority Projects (e.g., Redevelopment Programs, individual stand-alone projects)	Line Department Project Manager for subject program or project	Project Engineer/Architect (a.k.a. LEA) for subject program or project

The team conceptual planning meeting is intended to provide an early opportunity for the PA Line Department staff, PA Engineering staff, tenants and tenant representatives, and other affected stakeholders to meet and discuss the framework for required deliverables and future coordination efforts with the PA as part of TAA projects, new leases, lease renewals, and Port Authority projects. This meeting is also intended to minimize delays and streamline the project delivery process by providing all affected stakeholders with an opportunity to collaborate and discuss design concepts and ideas early in the project planning process, and to resolve issues before they become problematic. For this reason, the team conceptual planning meeting should take place at project inception, prior to the preparation or submittal of any formal studies, reports, design drawings, or other such documents. Items that may be discussed at this meeting may include, but are not limited to, the following:

1. Key operational and design issues, opportunities, and constraints for the project and how they will be addressed, particularly with respect to the access management guidelines described in this document;
2. The type of studies, and scopes-of-work for such studies, to be conducted by the PA, tenants, or tenant representatives;
3. Need for, and frequency of, on-going coordination meetings among affected stakeholders;
4. Follow-up communication and data exchange protocols among affected stakeholders;
5. Deliverables to be submitted to the PA, and associated schedule for their delivery;
6. Other items, as necessary.

Meeting minutes should be prepared for the team conceptual planning meeting to identify the issues discussed at the meeting and how they were resolved, or will be resolved, going forward.

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2.6 Including Access Management in the Transportation Planning Process

Implementing roadway access management at the Port Authority also involves including access management in the preparation of transportation master plans and/or sub-area plans. It may also involve conducting specific transportation studies at the request of Port Authority Engineering. The following sub-sections provide guidance with respect to each of these project types.

2.6.1 Preparing a Transportation Master Plan

A *transportation master plan* is a system-wide transportation plan for an entire Port Authority facility, prepared to accommodate projected changes in land development patterns and provide a supporting transportation system. Its purpose is to establish a strategy for providing reasonable access to all properties, while restoring or preserving the integrity of the transportation system, through careful consideration of access management principles. The primary benefit of having such a plan is that it lays the foundation for correcting existing access management problems and preventing others from occurring in the future. It also helps implement access management at a system-wide level and provide a framework for the consistent application of access management throughout the facility. *Table 2-2* illustrates a conceptual sequence for the preparation of a transportation master plan that reflects the needs of motorists, pedestrians, bicyclists, and transit users.

Even if a transportation master plan does not exist and circumstances do not allow for its creation, *Table 2-2* provides a framework or flow chart for applying the access management guidelines in this document.

Table 2-2: Framework for Preparing a Transportation Master Plan

Step No.	Task	Chapter Reference in these Guidelines
1	Identify the Port Authority facility under consideration.	Not applicable
2	Identify the modes of transportation that will be accommodated at the facility in the master plan.	Not applicable
3	Identify existing and/or proposed freeways and interchanges that will be used to access this facility.	Not applicable
4	Identify existing and/or proposed arterial roadways that connect these interchanges with the facility.	Not applicable
5	Identify existing and/or proposed bicycle facilities and transit services that will be used to access the facility.	Not applicable
6	Identify desirable locations for signalized intersections on these arterial roadways.	*Chapter 7*
7	Locate (or relocate) signalized intersections as close to the desirable locations as possible. [Note: Proper location and spacing of traffic signals is one of the most important decisions in access management due to the impact that signal location has on traffic progression along the corridor.]	*Chapter 7*
8	Layout existing and proposed walkways, bicycle trails, and vehicular roadways as a supporting grid. A. Identify roadway classifications for each roadway. B. Plan access to land in the vicinity of interchanges. C. Identify walkway network for pedestrians, including missing links to be completed.	*Chapter 13* *Chapter 3* *Chapter 8* Not Applicable
9	Determine existing and future roadway cross-sections to accommodate the applicable modes of travel. A. Even if traffic volumes are low and development densities are low, strongly consider non-traversable medians on principal arterial, arterial and collector roadways. B. Plan the site-access and circulation patterns based on roadway cross-sections, reflecting the needs	*Chapter 4*

	of motorists, pedestrians, bicyclists, and transit users [Note: Having a cross-section with a non-traversable median is one of the most important decisions in access management. The installation of a non-traversable median precludes direct left-turns into and out of driveways. Left-turns are associated with 74 percent of driveway-related crashes.]	
10	Provide the appropriate roadside buffer on all roadways based on future needs and volumes.	*Chapter 10, Section 10.1*
11	Identify desired driveway locations using guidelines.	*Chapters 13, 5 and 6*
12	Identify locations for left-turn and right-turn lanes.	*Chapters 11 and 12*

2.6.2 Preparing a Sub-Area Plan

Although having a transportation master plan is desirable, circumstances may exist where one is not available and access management will need to be applied in the absence of such a plan. In these situations, the development and application of a *sub-area plan* is important. A sub-area plan is a transportation plan that addresses mobility and access needs, including pedestrian, bicycle, and transit accommodations and mobility for a specific area of a Port Authority facility. The sub-area may include one or more tenant leaseholds within a Port Authority facility and/or one or more roadways.

Like a transportation master plan, a sub-area plan provides a framework for the consistent application of access management to accommodate potential changes in land development patterns. A sub-area plan is useful for dealing with specific areas of a facility that are undeveloped or areas where redevelopment is possible. It may address the leaseholds occupied by one or more tenants, the adjacent roadways, and access to those roadways. It may also address areas within a Port Authority facility having roadways that are programmed for improvement or driveways that need to be consolidated or realigned. A sub-area plan may be prepared as an integral component of a transportation master plan or as an independent effort; in either case, it should incorporate provisions for coordination of future growth with improvement of the roadway network.

2.6.3 Scoping Transportation Studies

In some instances, Port Authority Engineering may request the preparation of a formal traffic or transportation study, requiring field data collection, crash history and/or operational analyses, and written documentation of findings. Although the specific scope of each traffic/transportation study should be tailored to the needs of the project, the following sub-section presents a broad listing of potential scope items that may need to be studied.

The following is a model scope of work for transportation studies needed as part of a site-specific development or a redevelopment program. It is intended as a reference to support a team conceptual planning meeting with Port Authority Engineering. The actual detailed scope of work would be a product of this meeting, and include any or all of the following work items:

- **Preliminary Transportation Assessment**
    - Identify project characteristics: land uses, sizes
    - Provide conceptual sketch of site layout, including potential location and configuration of:
        - Buildings
        - Access driveways to the subject property or properties, including traffic control devices (e.g., STOP signs, traffic signals, etc.) and allowable vehicle movements (e.g., left-turns, through movements, and right-turns).
        - Sidewalks
        - Drive aisles and parking spaces
        - Drive-through locations
        - Bicycle facilities and accommodations (e.g. bicycle parking)

    - Security booths
    - Other items
  - Define design vehicle and its parameters
  - Identify signing requirements
  - Identify potential transportation safety and operations issues, and recommended solutions, including those related to pedestrian and bicycle network connectivity

- **Transportation Operations Impact Analysis**
  - Scoping
    - Identify critical peak hours for study
    - Identify build (horizon) year(s)
    - Prepare trip generation estimate (mode split, person-trips, vehicle-trips)
    - Prepare trip distribution estimate
    - Prepare trip assignment
    - Identify interchange and/or intersection study locations
    - Identify crosswalk, sidewalk, and street-corner study locations
    - Identify Measures of Effectiveness (MOEs) for analysis
  - Existing Conditions Analysis
    - Identify existing conditions data needed
    - Conduct 24-hour Automatic Traffic Recorder (ATR) volume counts
    - Conduct intersection turning movement counts
    - Conduct pedestrian movement counts
    - Conduct bicycle movement counts
    - Prepare volume flow diagrams
    - Conduct operational analyses
    - Identify existing operations and crash history issues
  - Future Conditions No-Build Analysis
    - Identify soft sites and associated vehicle, pedestrian, and bicycle traffic volumes
    - Identify background traffic growth factor
    - Estimate future No-Build volumes
    - Conduct operational analyses
  - Future Conditions Build Analysis
    - Superimpose project-generated vehicle, pedestrian and bicycle traffic on future No-Build volumes
    - Conduct operational analyses
    - Identify potential project-related impacts
    - Identify, analyze, and recommend mitigation measures
  - Other Analyses
    - Transportation Crash History Analysis (see below)
    - Traffic Signal Warrant Analysis (see below)
    - Intersection sight distance analysis (see below)
    - Arterial operational analysis
    - Freeway weaving analysis
    - Assessment of vehicle turning paths and horizontal driveway profile
    - Assessment of vertical driveway profile
    - Assessment of connectivity of pedestrian facilities (e.g. sidewalks and pedestrian paths)
    - Assessment of bicycle access and connectivity to the local and regional roadway and bicycle networks

- **Crash History Analysis**
  - Summarize crash data for most recent 3- to 5-year period by:
    - Crash type (i.e., rear-end, left-turn, etc.)
    - Crash participants (i.e., motorist, pedestrian, bicyclist, etc.)

        - Crash severity (i.e., fatality, injury, property damage only), and
        - Prevailing conditions (i.e., pavement conditions, weather conditions, etc.)
    - Prepare collision diagrams
    - Identify key factors contributing to crashes
    - Recommend crash countermeasures / safety improvements

- **Traffic Signal Warrant Analysis**
    - Refer to guidance and procedures in the [Port Authority] *Intersection Signalization Procedures* for traffic signal warrant analyses

- **Other Transportation Analyses, Studies, and Surveys**
    - Intersection sight distance analysis
        - Field measurement of existing sight distance
        - Calculation of needed sight distance
    - Travel time survey
    - Vehicle speed survey
    - Origin-destination survey
    - Vehicle classification survey
    - Queuing analysis
        - Signalized and unsignalized intersections
        - Access driveways
        - Toll booths
        - Access gates (entry and exit)
    - Parking studies
        - Existing parking utilization
        - Existing parking duration and turnover
        - Future parking demand projections
    - Travel behavior surveys
        - Mode split survey
        - Origin-destination survey (verbal)
        - Pass-by trip rate or linked-trip rate surveys

2.7 Applying Roadway Access Management Guidelines at Port Authority Facilities

The Port Authority's facilities are constantly undergoing changes. These changes could be related to tenant alterations, roadway improvement projects, new development and redevelopment actions for specific sites and tenants, and large redevelopment programs for a facility. During the course of these projects, design decisions need to be made regarding the proper location and design for a driveway or intersection, as well as what type of traffic control (e.g., traffic signal, stop-control, etc.) is most suitable at the location. In addition, there are decisions regarding where channelization features and non-traversable medians should be installed, where breaks in non-traversable medians should be located, how much sight distance is needed, and what is the necessary width of the roadside buffer.

The roadway access management guidelines contained in the following chapters of this document have been established to help identify these options and develop the best solutions to a range of possible access management-related issues. The guidelines reflect the functional hierarchy (i.e., the level of importance) of the individual roadways at Port Authority facilities and are intended to be applied as the opportunities to make access-related changes at Port Authority facilities arise over time.

Table 2-3 presents an overview on how to apply sequentially the guidelines in this document at a Port Authority facility. The sequence shown in *Table 2-3* should be taken as development or redevelopment occurs in

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accordance with the decisions made at the team conceptual planning meeting.

Table 2-3: Process for Applying Roadway Access Management Guidelines

Step Number	Tasks	Chapter and Section references in these *Guidelines*
1	Consult and use the transportation master plan and/or the applicable sub-area plans, if available	*Chapter 2: Sections 2.6.1 and 2.6.2*
2	Identify the access classification of existing and proposed roadways	*Chapter 3*
3	Determine preliminary cross-sections and roadside buffers for existing and proposed roadways	*Chapters 4 and 10*
4	Locate intersections and driveways at desired locations	*Chapters 5, 6, 7, 8, and 13*
5	Provide for proper intersection sight distance	*Chapter 10: Section 10.2*
6	Design driveways, including left-turn and right-turn lanes	*Chapters 9, 11, and 12*
7	Only as a last resort, consider requesting a design exception from these *Guidelines*	*Chapter 14*

2.8 References to Guidelines in Other Port Authority Documents

These *Guidelines* have also been integrated into other Port Authority documents, by reference, to reinforce their application throughout the agency. *Table 2-4* identifies references to these *Guidelines* in other Port Authority documents.

Table 2-4: References to Other Port Authority Documents

Document	References to *Roadway Access Management Guidelines* found in:
Tenant Construction and Alteration Process (TCAP) Manual	Section 1.6
Tenant Construction Review Manual	Section 2, Subsection VIII
Traffic Engineering Design Guidelines	Section 3.0, Subsection 3.2.3.11

2.8.1 How To Find Tenant Construction and Alteration Process (TCAP) Manual

The *Tenant Construction and Alteration Process (TCAP) Manual* can be obtained by either of the following methods:

1. **Go to the following link:**

http://www.panynj.gov/business-opportunities/tcap/pdf/tcap-manual.pdf

OR

2. **Navigate from the Port Authority's home page (www.panynj.gov) as follows:**

2a. Click on "Port Authority of NY & NJ"

2b. Under "Business Opportunities" click "Learn More"

2c. Under "Tenant Construction Alteration" click "Learn More"

2d. Click "View the Tenant Construction and Alteration Process Manual"

2.8.2 How To Find Tenant Construction Review Manual

The *Tenant Construction Review Manual* can be obtained by using the following link:

http://www.panynj.gov/business-opportunities/tcap/pdf/7.5-References/7.5.1-all-facil/7.5.1-01.pdf

2.8.3 How To Find Traffic Engineering Design Guidelines

The *Traffic Engineering Design Guidelines* can be obtained by either of the following methods:

4. **Go to the following link:**

http://www.panynj.gov/business-opportunities/pdf/discipline-guidelines/traffic.pdf

OR

5. **Navigate from the Port Authority's home page (www.panynj.gov) as follows:**

2a. Click on "Port Authority of NY & NJ"

2b. Under "Business Opportunities" click "Learn More"

2c. Under "Engineering Documents" click "Learn More"

2d. Under "Discipline Guidelines" click "Traffic"

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CHAPTER 3: ROADWAY ACCESS CLASSIFICATION SYSTEM

3.1 Overview

A roadway *access classification system* (ACS) is typically used to establish the level of allowable access for roadways of varying levels of importance in the transportation system. An ACS is a hierarchy of access categories that forms the basis for the application of access management to all roadways.[4] Each access category has related criteria governing the access-related standards and characteristics for corresponding roadways. These access categories ultimately define where access can be allowed on the roadway system and abutting properties, and where it should be denied or discouraged. For purposes of applying access management to Port Authority facilities, an ACS was established. This chapter provides a description of the ACS and presents the associated access category assignments at Port Authority facilities.

3.2 Access Classification System for Port Authority Roadways

Table 3-1 provides an overview of the access classification system developed for Port Authority facilities. As shown in the table, the ACS establishes a tiered system of access categories based on the known functionality of individual roadways at Port Authority facilities. This first edition of the *Port Authority Roadway Access Management Guidelines* document provides detailed guidelines for General Roadway Access Classifications listed in *Table 3-1*. *Table 3-1* also identifies airport-specific roadway classifications, including airport terminal frontage roads, restricted vehicle service roads, and recirculation roads. These are special types of roadways at Port Authority facilities, serving unique functions and accommodating specific user-groups. Guidelines for these roadways will be addressed in a future edition of this document.

Because freeways – roadways that do not provide direct access to properties – are of the greatest level of importance in traffic mobility, they represent the highest category within the access classification system. Design criteria for freeways are established in sources such as AASHTO's *A Policy on Geometric Design of Highway and Streets* (i.e., the "Green Book").

The next tiers of the Port Authority ACS include "principal arterial" and "arterial" roadways at Port Authority facilities. On these roadways, the priority is given to serving through traffic, with direct property access a secondary function. Principal arterials are distinguished from arterials by their accommodation of high percentages of trucks in the traffic stream (i.e., percentages typically found at port facilities). Collector roadways provide both a mobility function – by accommodating through traffic traveling between local roads and arterials – as well as a property access function.

Local roads and private roads primarily provide direct access to abutting properties, but they may also accommodate relatively low volumes of through traffic. Whereas private roads are located within tenant leasehold areas and typically designed, operated, and maintained in accordance with negotiated tenant lease agreements, local roads are owned, operated, and maintained by the Port Authority. Local roads and private roads generally have lower posted speeds than higher classification roadways (i.e., principal arterial, arterial, and collector roadways).

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[4] An ACS is not a roadway design functional classification system such as found in AASHTO's "Green Book."

Table 3-1: Port Authority Roadway Access Classification System

Access Classification	Functional Description	Traffic Flow Characteristics	Vehicle Types	Operational Characteristics	Other Distinguishing Characteristics
General Roadway Access Classifications[1]					
Freeway (including mainline freeways and ramps)	Exclusively used for the movement of through traffic. Does not serve any property access function (no driveways).	Exclusively uninterrupted traffic flow.	Typical	N/A	N/A
Principal Arterial Road	Primarily used for the movement of through traffic; access to abutting land uses is subordinate to through traffic movement.	Interrupted traffic flow.	Serves a higher percentage of trucks compared to an arterial road.	N/A	Road is used as a major detour route on a routine basis. Installing non-traversable medians is desirable as part of redevelopment programs.
Arterial Road			Serves a lower percentage of trucks compared to a principal arterial.	N/A	N/A
Collector Road[2]	Provides both land access and traffic circulation functions, collects traffic to/from local streets and channels it to/from arterials.	Interrupted traffic flow.	Typical	N/A	N/A
Local Road[3]	Primarily provides direct access to abutting land uses, very low level of through traffic movement.	Interrupted traffic flow; low operating speed.	Typical	N/A	N/A
Private Road Open For Public Travel	Same as Local Road.	Same as Local Road.	Typical	N/A	A local road within a tenant leasehold area. Tenant has jurisdiction based on a negotiated lease agreement.
Airport-Specific Roadway Access Classifications					
Terminal Frontage Road	Serves as one of the designated passenger drop-off and pick-up locations at a terminal (e.g., airline terminal, bus terminal, or AirTrain station).	Uninterrupted or interrupted traffic flow.	No trucks.	Very low speed.	Little, if any, through traffic.
Restricted Vehicle Service Road (RVSR)	Local road, typically within the Aeronautical Operations Area (AOA). Restricted: special drivers and special vehicles with a unique identification and registration system. Service: Primary function is circulation of aircraft service vehicles within the AOA. Small percentage of through traffic. Similar to factory floor with forklifts moving to facilitate the manufacturing of products.	Interrupted traffic flow.	Unique vehicle types: baggage carts (Tugs), airplane fuel trucks, catering and other service trucks with vertical lift payloads. The most common vehicle is a tug pulling trailers of luggage.	Very low speed.	During certain times of the day, the volume of vehicles providing various services to planes at gates far exceeds the volume of through traffic. Unique security requirements associated with the identification system. All points of entry to the AOA are controlled by guard posts, whether they are vehicular or pedestrian access points.
Recirculation Road	Shortcut to allow vehicles to return to the terminal frontage(s).	Uninterrupted or interrupted traffic flow.	Almost exclusively passenger vehicles.	Same, or similar, speeds to adjacent road segments.	Partially-controlled access (no driveways).

1. The classification of a roadway must be consistent for the entire width of its cross-section at any point on the roadway. (Example: The frontages at EWR Terminals A, B, C are classified "Airport Terminal Frontage Road" across their entire cross-section even though the left most lane is a "through only" lane from which no stopping is permitted.)
2. The connecting roads (typically one-way ramps) upstream and downstream of an airport terminal frontage are typically considered to be collector roads. (Examples: The roads that lead to and from the frontages at EWR Terminals A, B, C are collector roads.)
3. When a connecting road only serves the frontage (i.e., there is no through traffic on the road), it is considered to be a local road. (Examples: The roads that lead to and from the frontages at EWR AirTrain Stations P2 and P4 are local roads.)

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Table 3-2 presents some example roadways corresponding to each access classification from among selected Port Authority facilities. Readers who are familiar with the roadways at one or more Port Authority facilities will gain a better understanding of the roadway access classifications by considering the examples in *Table 3-2*.

Table 3-2: Example Roadway Classifications by Port Authority Facility

Access Classification	Newark Airport	JFK Airport	LaGuardia Airport	Teterboro Airport	Stewart Airport	Port Newark-Elizabeth Marine Terminal
General Roadway Access Classifications[1]						
Freeway (including mainline freeways and ramps)	I-78 Connector; Express Rd.	JFK Expressway; Van Wyck Expressway	Ramps to/from Grand Central Parkway	None	None	None
Principal Arterial Road	None	The sequence of roads: North Boundary Rd., 150th Ave., 147th St., and Cargo Service Rd. (which serve as the detour route when Van Wyck Expressway is closed).	None	None	None	McLester Street/Corbin Street, Lyle King St., Port St. from NJTPK to Doremus Ave.
Arterial Road	Brewster Rd; Earhart Dr., At-Grade Parking Roadway, Lindbergh Rd.	Lefferts Blvd.	Runway Dr., LaGuardia Rd.	None	Stewart Blvd.	None
Collector Road[2]	Conrad Rd.	Cargo Plaza Rd.	Central Terminal Dr., Bowery Bay Blvd., Marine Terminal Road	None	Bruenig Rd.	Port St. from Doremus Ave. to Craneway St.; Polaris St.
Local Road[3]	Carson Rd.	North Hangar Rd.	Fiorello Lane	Charles Lindbergh Rd.	First St.	Export St., Calcutta St.
Private Road Open For Public Travel	Airis Dr.	Access Road to Building 9	None	South end of Fred Wehran Drive	None	Panama Street
Airport-Specific Roadway Access Classifications						
Terminal Frontage Road	Frontage roadways at Terminal A, B, C. Frontage roadways at AirTrain stations P2 and P4.	Frontage roadways for Terminals 1 through 8.	Frontage roadways for Terminals A through D.	Frontages at Buildings 111, 112.	Terminal frontage roadway	None
Restricted Vehicle Service Road (RVSR)	Fuel Farm Road	RVSR	RVSR	RVSR	Perimeter Road	None
Recirculation Road	Recirculation Rd.	Typical recirculation roads	None	None	None	None

1. The classification of a roadway must be consistent for the entire width of its cross-section at any point on the roadway. (Example: The frontages at EWR Terminals A, B, C are classified "Airport Terminal Frontage" across their entire cross-section even though the left most lane is a "through only" lane from which no stopping is permitted.)
2. The connecting roads (typically one-way ramps) upstream and downstream of an airport terminal frontage are typically considered to be collector roads. (Examples: The roads that lead to and from the frontages at EWR Terminals A, B, C are collector roads.)
3. When a connecting road only serves the frontage (i.e., there is no through traffic on the road), it is considered to be a local road. (Examples: The roads that lead to and from the frontages at EWR AirTrain Stations P2 and P4 are local roads.)

3.3 Access Classification Assignments for Roadways at Port Authority Facilities

3.3.1 Assignments in This Edition

Assignments of roadway access classifications to specific Port Authority facility roadways were based on comprehensive reviews performed by Port Authority Traffic Engineering, using the access categories described above, and with knowledge of the physical constraints and operational parameters of the roadways at each Port Authority facility. *Figures 3-1* through *3-6* show the access classification assignments to individual roadways at each Port Authority facility, as follows:

- *Figure 3-1*: Roadway Access Classification Map for Newark Liberty International Airport (EWR)
- *Figure 3-2*: Roadway Access Classification Map for Newark Liberty International Airport (EWR) – Terminal Area
- *Figure 3-3*: Roadway Access Classification Map for John F. Kennedy International Airport (JFK)
- *Figure 3-4*: Roadway Access Classification Map for John F. Kennedy International Airport (JFK) – Central Terminal Area
- *Figure 3-5*: Roadway Access Classification Map for LaGuardia Airport (LGA)
- *Figure 3-6*: Roadway Access Classification Map for Teterboro Airport (TEB)
- *Figure 3-7*: Roadway Access Classification Map for Stewart International Airport (SWF)
- *Figure 3-8*: Roadway Access Classification Map for Port Newark-Elizabeth Marine Terminal

Subsequent chapters of these *Guidelines* identify the associated access spacing and design criteria based on the access categories described in this chapter.

As new Port Authority facilities are acquired over time, and as improvements are made to existing facilities, the access classification assignments to individual roadways may need to be revisited and should be updated over time following the completion of construction.

3.3.2 Assignments in Future Editions

This first edition of this document contains roadway access classifications and associated access management guidelines for roadways at Port Authority port facilities and aviation facilities (excluding airport-specific roadways). Roadway access classifications and guidelines for the following facilities will be addressed in a future edition of this document:

- New port commerce facilities (Greenville Yard and Port Jersey Port Authority Marine Terminal)
- Bridge and tunnel facilities
- Airport-specific roadways
- Development sites managed by the Real Estate Services Department

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***Figure 3-1**: Roadway Access Classification Map for Newark Liberty International Airport (EWR)*

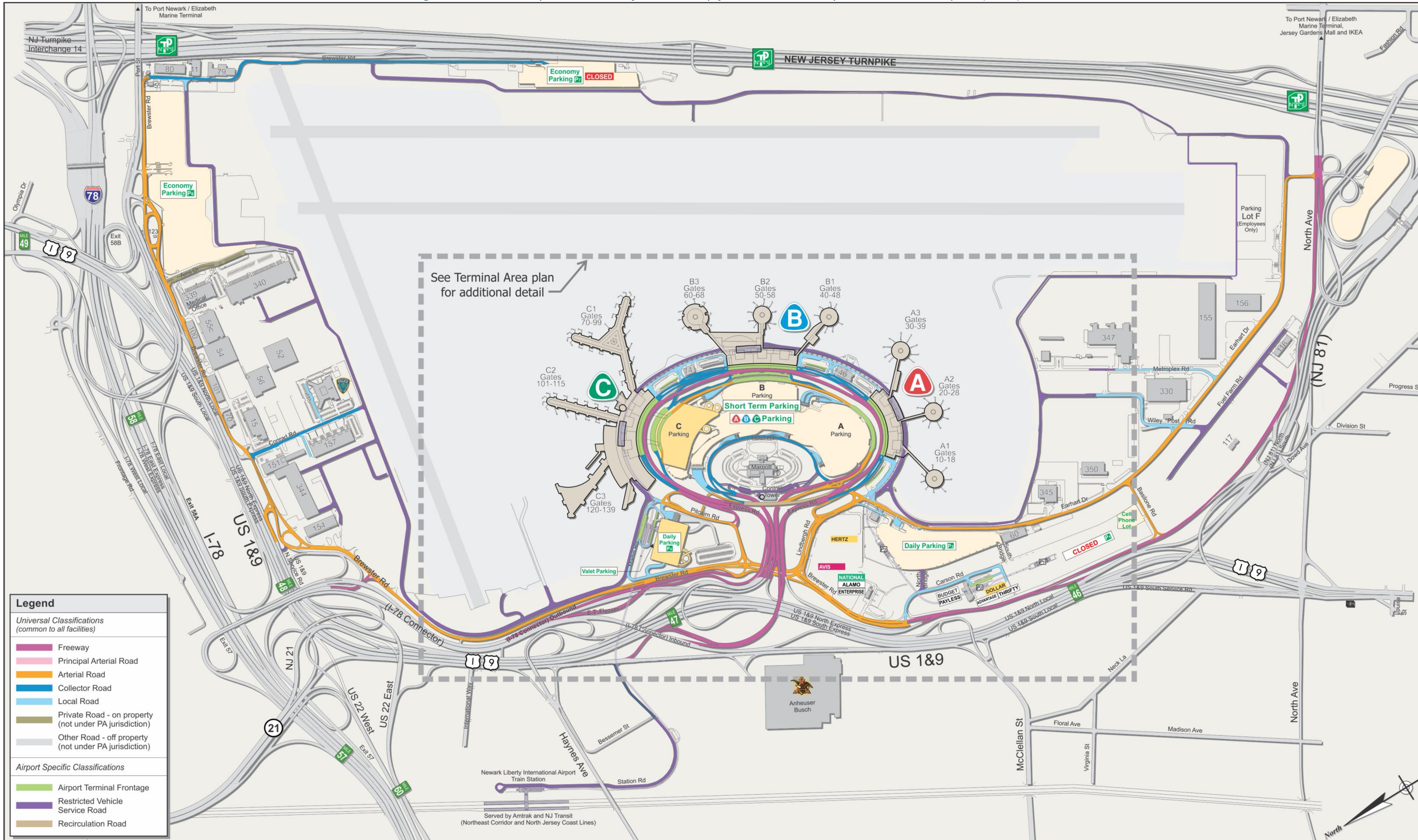

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***Figure 3-2**: Roadway Access Classification Map for Newark Liberty International Airport (EWR) – Terminal Area*

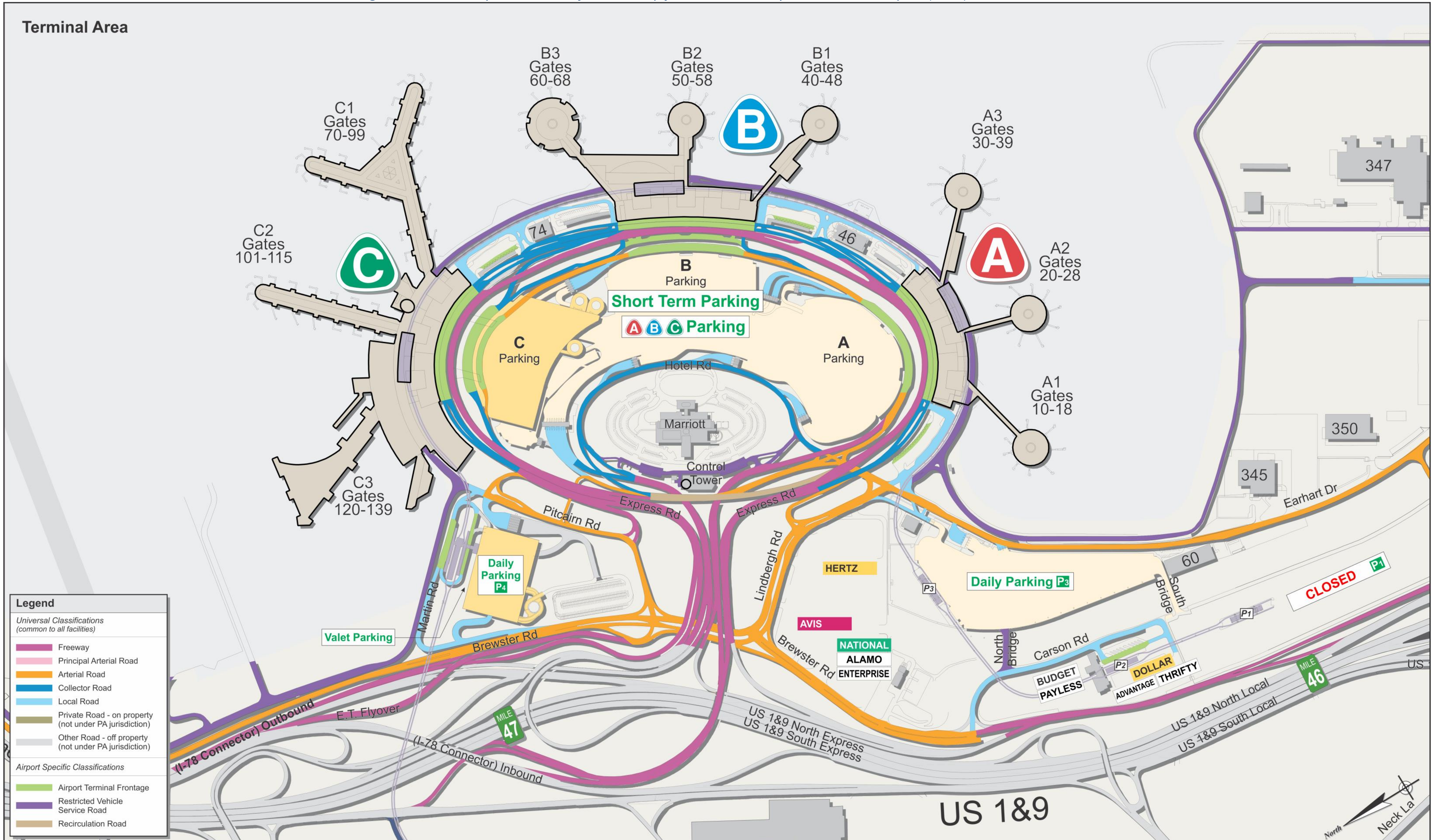

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***Figure 3-3**: Roadway Access Classification Map for John F. Kennedy International Airport (JFK)*

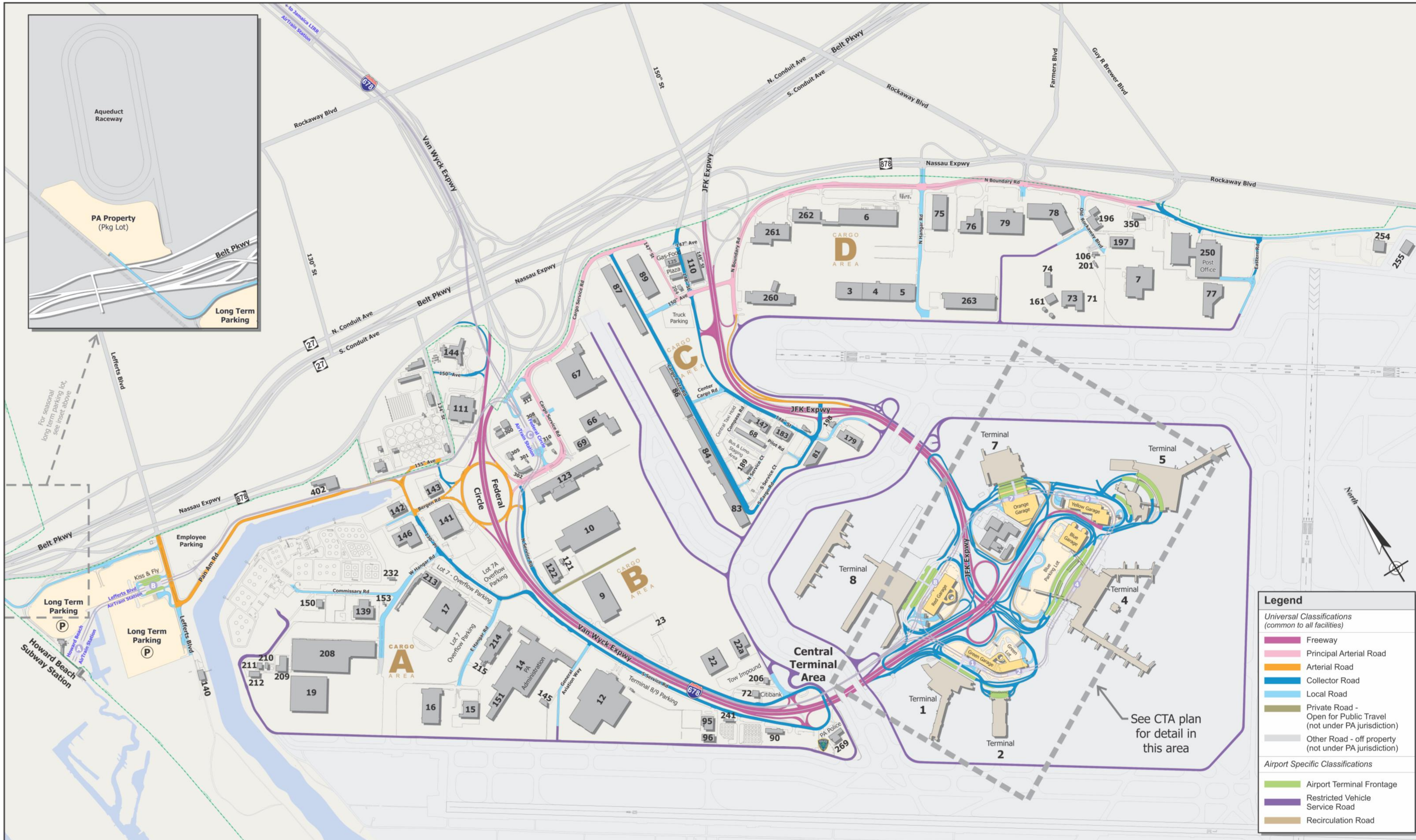

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***Figure 3-4**: Roadway Access Classification Map for John F. Kennedy International Airport (JFK) – Central Terminal Area*

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***Figure 3-5**: Roadway Access Classification Map for LaGuardia Airport (LGA)*

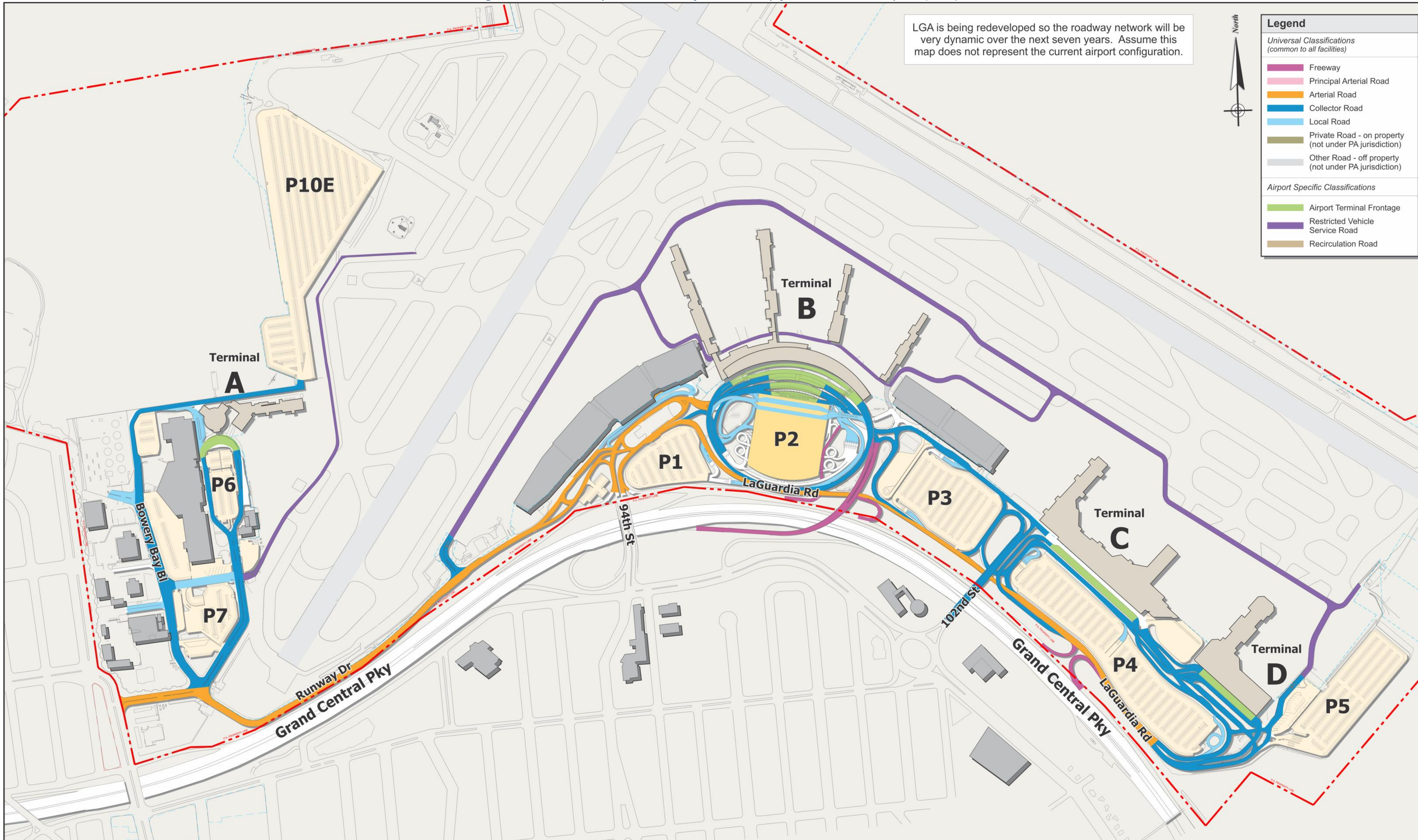

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***Figure 3-6**: Roadway Access Classification Map for Teterboro Airport (TEB)*

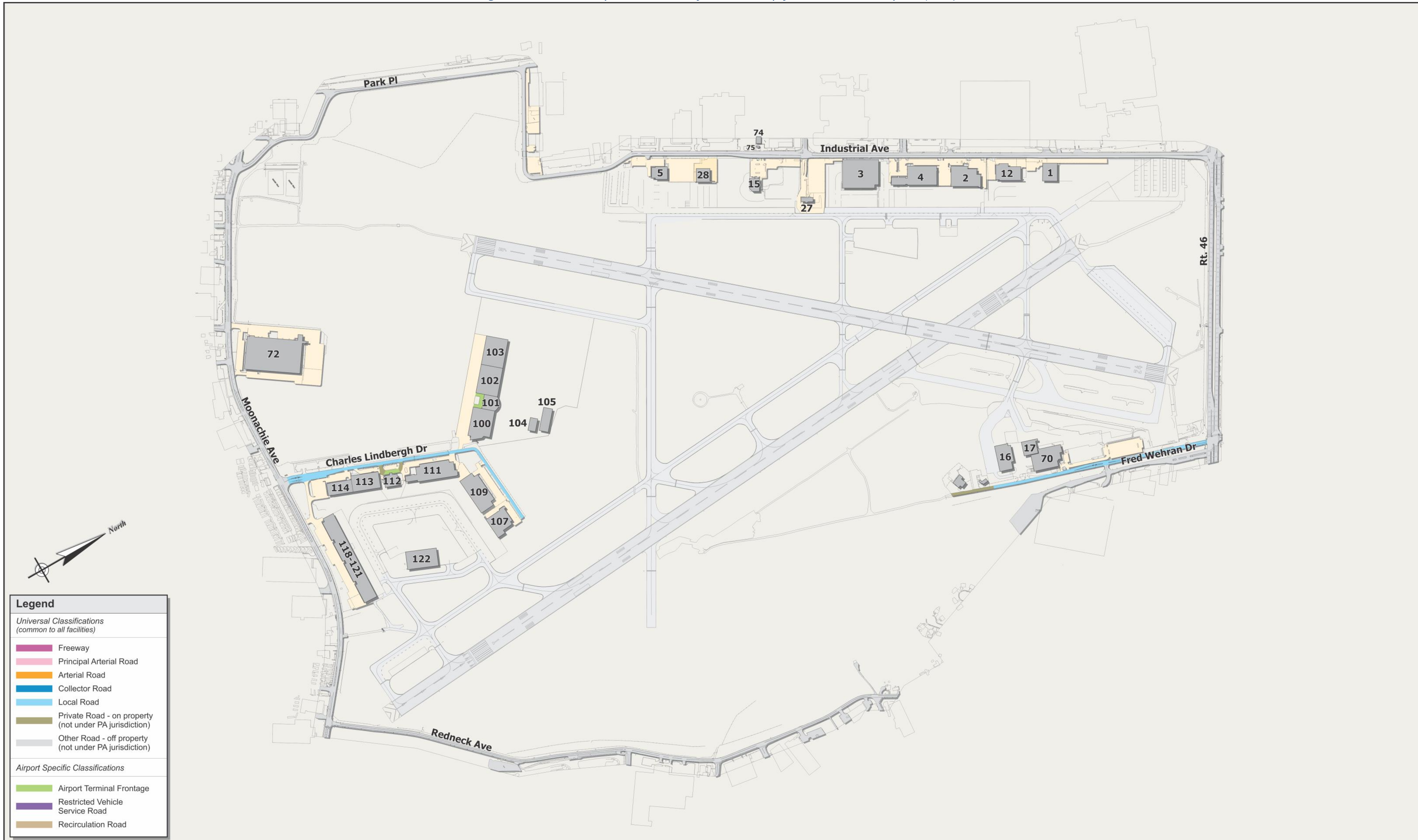

***Figure 3-7**: Roadway Access Classification Map for Stewart International Airport (SWF)*

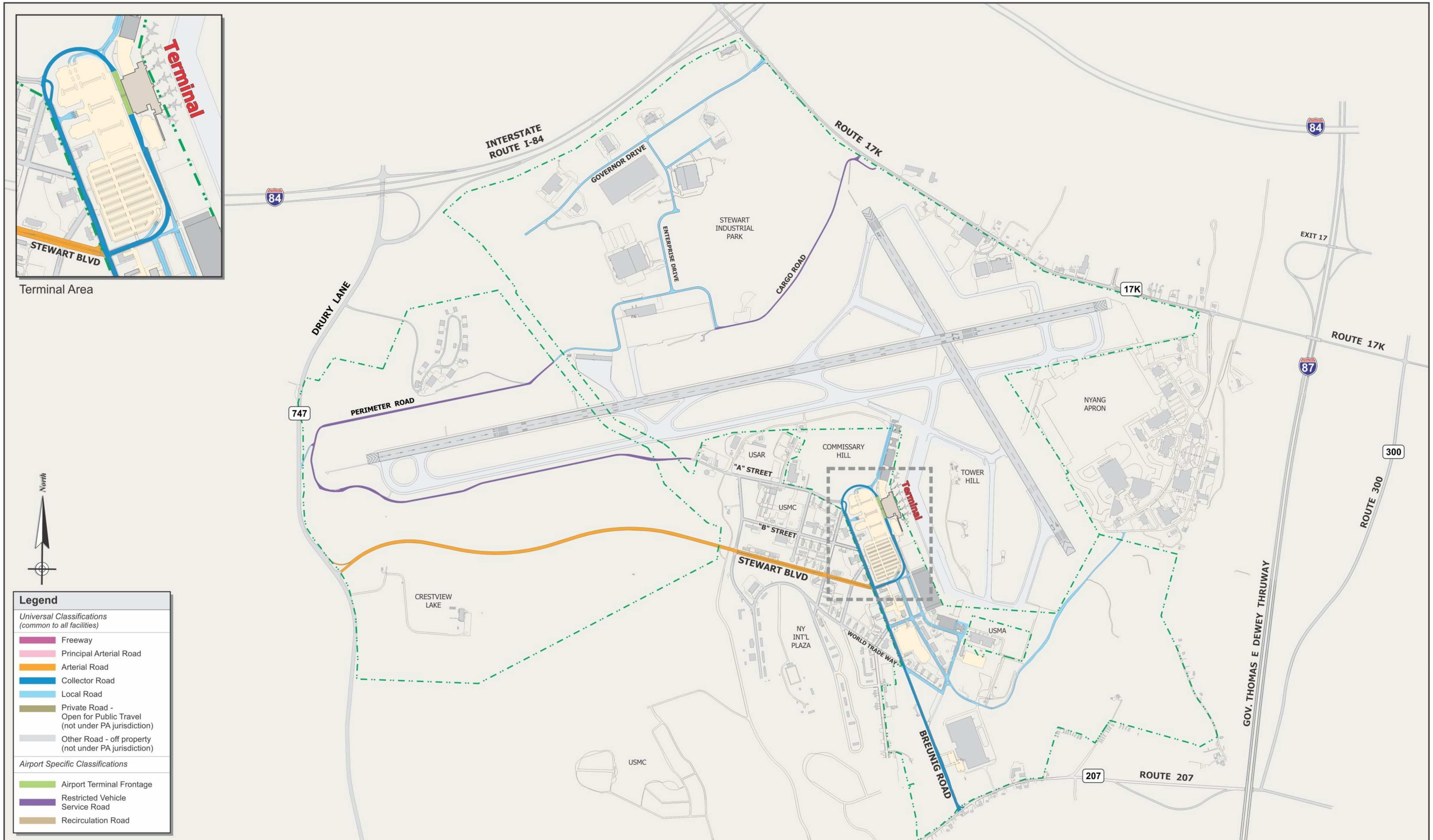

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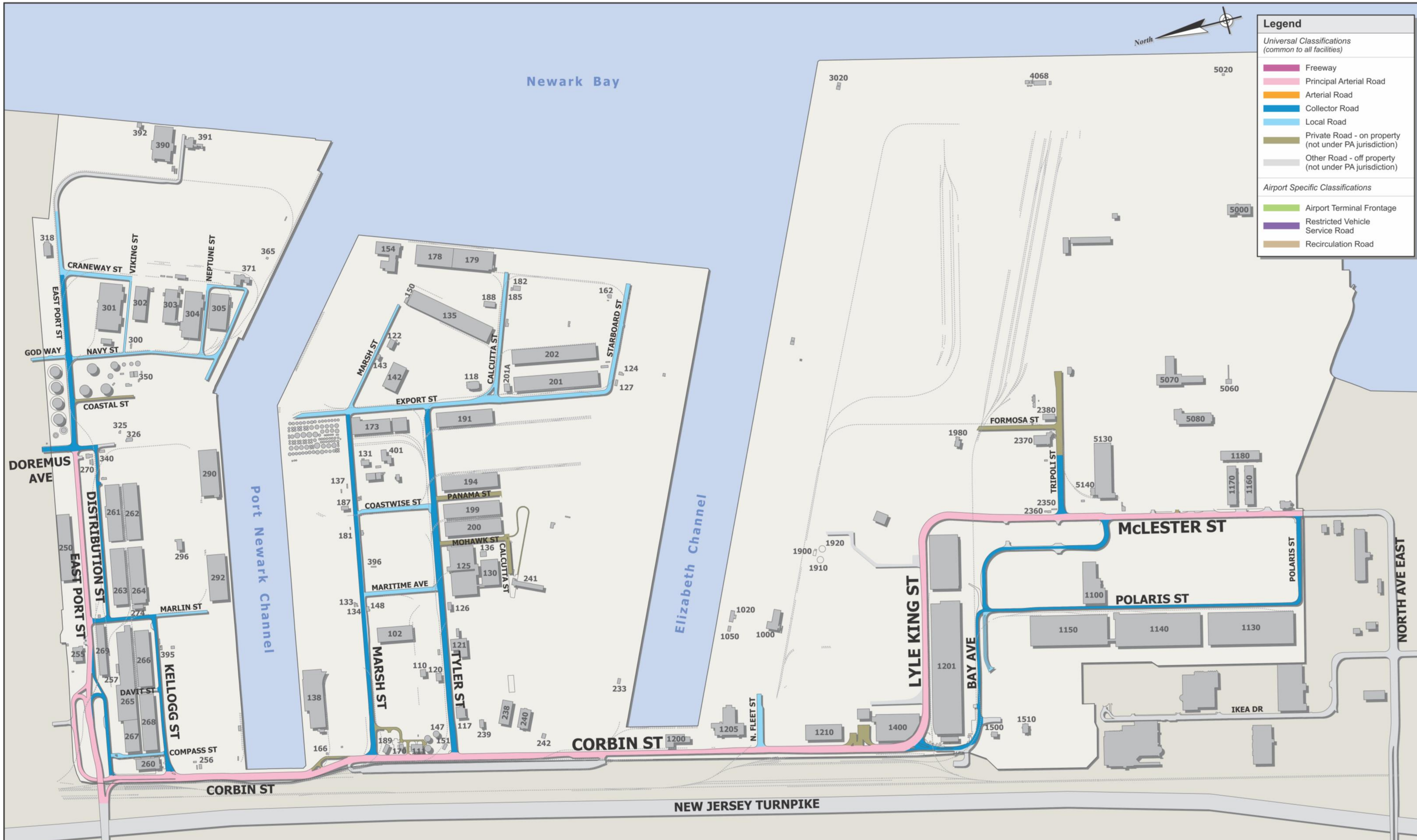
***Figure 3-8**: Roadway Access Classification Map for Port Newark-Elizabeth Marine Terminal*



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CHAPTER 4: ROADWAY CROSS-SECTIONAL ELEMENTS

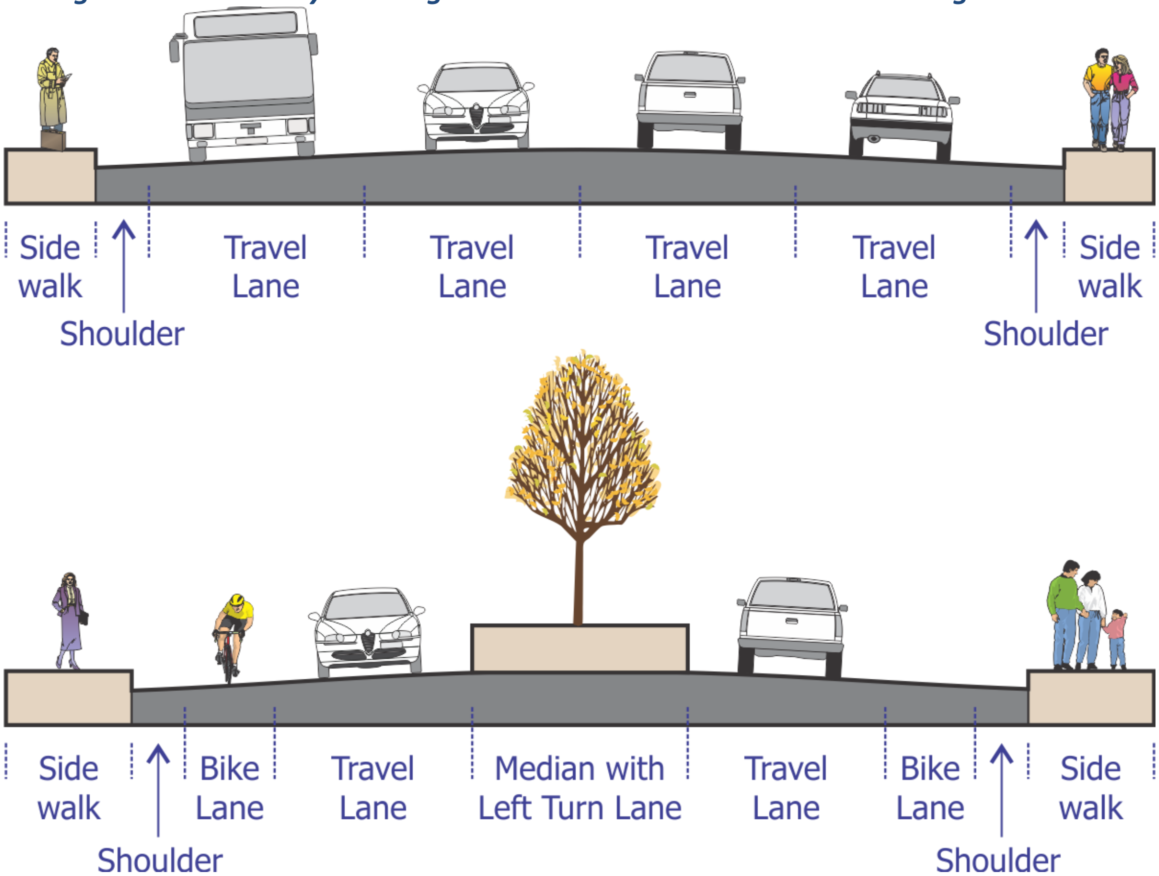
4.1 Overview

Roadways at Port Authority facilities differ from one another in their access classifications and intended functions, as described in *Chapter 3*. They also differ with respect to their specific design characteristics and the user groups they are intended to accommodate. Therefore, no "one size fits all" design solution applies to all situations. Moreover, constraints on the physical width of the roadway may preclude the provision of beneficial cross-sectional elements in a specific roadway design. Ultimately, applicable Port Authority policies and stakeholder input should drive the decision-making process as to which cross-sectional elements are most appropriate for a given roadway. To help inform that decision, this chapter provides general principles and guidance regarding a number of those elements for consideration in roadway planning or design projects at Port Authority facilities.

Within the given cross-sectional width of a roadway, vehicular traffic has to be accommodated. However, Port Authority roadways should, where appropriate, also include design features supporting other modes of travel — such as sidewalks for pedestrians, bike lanes for bicyclists, and bus pull-outs for transit. Additionally, cross-sectional elements such as non-traversable medians, auxiliary lanes, shoulders, and/or roadside buffers should be considered. Providing on-street parking may also be appropriate along some roadways. Having the space to accommodate all of these design treatments frequently would require roadway widening.

In practice, roadway widths are often limited by leasehold boundaries, existing buildings, environmental considerations, and other constraints that may rule out the possibility of widening the roadway. Therefore, each of the roadway design features noted above is in "competition" for physical space within the limited cross-section of the roadway. As a result, transportation practitioners often must consider trade-offs among these features in the design of the roadway cross-section, balancing the needs of the various users within the context of the surrounding area. The information in this chapter provides a general introduction to potential cross-sectional features and their benefits. *Figure 4-1* illustrates a roadway with different potential cross-sectional design features within the same roadway width. Note that the width necessitates choices be made between the different cross-sectional elements.

Figure 4-1: Roadway showing Various Potential Cross-Sectional Design Features



4.2 Complete Streets Concepts

4.2.1 What are Complete Streets?

According to the National Complete Streets Coalition[5], a *complete street* is one that is comfortable, convenient, and safe for travel by motorists, pedestrians, bicyclists, and transit users of all ages and abilities, as well as sensitive to the context of its surrounding land uses and environment. As such, complete streets are an important part of comprehensive solutions to transportation problems. For that reason, many transportation agencies have adopted a complete streets policy to advance the objective that roadways are planned, designed, and operated to accommodate all users safely as part of both new roadway construction projects and retrofit improvement projects. The goal of complete streets planning and design is to, over time, integrate the needs of multi-modal users as part of independent projects in order to ultimately create a complete, interconnected network of roadways that can safely and conveniently accommodate all travelers.

4.2.2 Why Make a Street "Complete"?

Complete streets allow travelers to choose between several safe, attractive, and convenient modal choices, rather than having to rely exclusively on the automobile for all travel. Roadways that include designated places for people to walk, cross lanes of moving traffic, catch a bus, and bicycle decrease the risk of crashes. On the other hand, "incomplete" streets — those designed only with motorized vehicles such as automobiles and trucks in

[5] http://www.completestreets.org/

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mind[6] — can limit transportation choices and may make walking, bicycling, and using transit inconvenient and unattractive.

As such, complete streets benefit quality of life and the environment. Complete streets encourage walking and bicycling — particularly for short- and medium-distance trips — which contributes to a healthy and active lifestyle. Moreover, walking and bicycling require no gasoline, and fuel consumption per passenger for transit vehicles is more efficient than that of automobiles. In addition to reduced fuel consumption and the associated cost savings, the multi-modal travel opportunities provided by complete streets can also help reduce vehicle emissions.

4.2.3 Port Authority Policies that Support Complete Streets Concepts

The Port Authority embraces the complete streets philosophy. Two policies enacted by the Port Authority Board that have applicability to complete streets concepts are the *Environmental Sustainability Policy* and the *Bicycle Policy*. By promoting pedestrian and bicycle accommodations and transit mobility through complete streets planning and design efforts, the Port Authority is taking steps toward achieving the goals of the Port Authority's *Environmental Sustainability Policy*, which states, in part:

> *The Port Authority will continue to use its best efforts to reduce all greenhouse gas (GHG) emissions related to its facilities by 80% from 2006 levels, by 2050. The reduction of GHG emissions by 5% annually will be the central focus of the Port Authority's sustainability efforts. The majority of these reductions will come from improvements made through new capital investments and changes in operations.*
>
> *The Port Authority will encourage its customers, tenants, and partners to conduct their businesses in a more sustainable fashion, including reductions in their own GHG emissions, providing support for these efforts in all cases where it is practical to do so.*[7]

Additionally, complete streets are supportive of the Port Authority's *Bicycle Policy*, which states, in part:

> *In keeping with its mission to meet the critical transportation needs of the bi-state region, the Port Authority supports bicycling as an important and sustainable mode of travel. It seeks to provide its customers, tenants, visitors and employees with safe and convenient bicycle access and secure bicycle parking at its facilities, wherever operationally and financially feasible.*
>
> *Goals of this policy include:*
>
> - *Integrate improved bicycle access, safe bicycle lanes, and secure bicycle parking and storage into existing Port Authority buildings and facilities, owned or operated by the Port Authority.*
> - *Ensure that design guidelines for new construction and major renovations include sufficient bicycle access, storage, and related amenities to meet emerging demand.*
> - *Remove any unnecessary restrictions on bicycle access, and promote the safe coexistence of motor vehicles, bicycles and pedestrians at Port Authority facilities.*

[6] Excluding freeways and expressways, which are intended to be high-speed and exclusively accommodate motor vehicle travel.

[7] *Port Authority Environmental Sustainability Policy*, approved March 27, 2008.

- *Encourage tenants to expand bicycle access and accommodations.*
- *Coordinate bicycle facility improvements and intermodal connections with regional planning organizations, other regional transportation providers, and local governments to promote safe and seamless travel throughout the region.*[8]

4.2.4 Complete Streets Guidelines for the Port Authority

As part of the effort to develop these *Roadway Access Management Guidelines*, a need was identified for guidelines addressing pedestrian and bicycle connectivity at Port Authority facilities and guidelines for providing transit at Port Authority facilities. The Port Authority Bicycle Master Plan, as indicated in its "Purpose" statement, provides a long-range vision to institutionalize bicycle planning, practices, and policies within the agency to accommodate the growing modal share of bicycling within the New York-New Jersey metropolitan region. The Port Authority is committed to monitoring cycling demand at its facilities and to making improvements and investments where necessary and feasible. The Bicycle Master Plan proposes strategies and potential implementation measures to achieve this vision, but its recommendations are wholly independent of the funding and prioritization decisions outlined in the agency's Capital Plan. Many strategies identified in this Bicycle Master Plan would not require significant capital investment and could have a positive impact on cycling in the region. These strategies could be integrated into existing operations and maintenance budgets based on the priorities and available resources within each Port Authority department.

4.3 Non-Traversable Median Treatments

Installations of non-traversable (i.e., raised) medians — with provisions for median openings to accommodate left-turns and U-turns (see *Photo 4-1*) — have proven to be among the most effective techniques for reducing conflicts and improving traffic operations along roadways.

Photo 4-1: Port Authority Roadways with Non-Traversable Medians

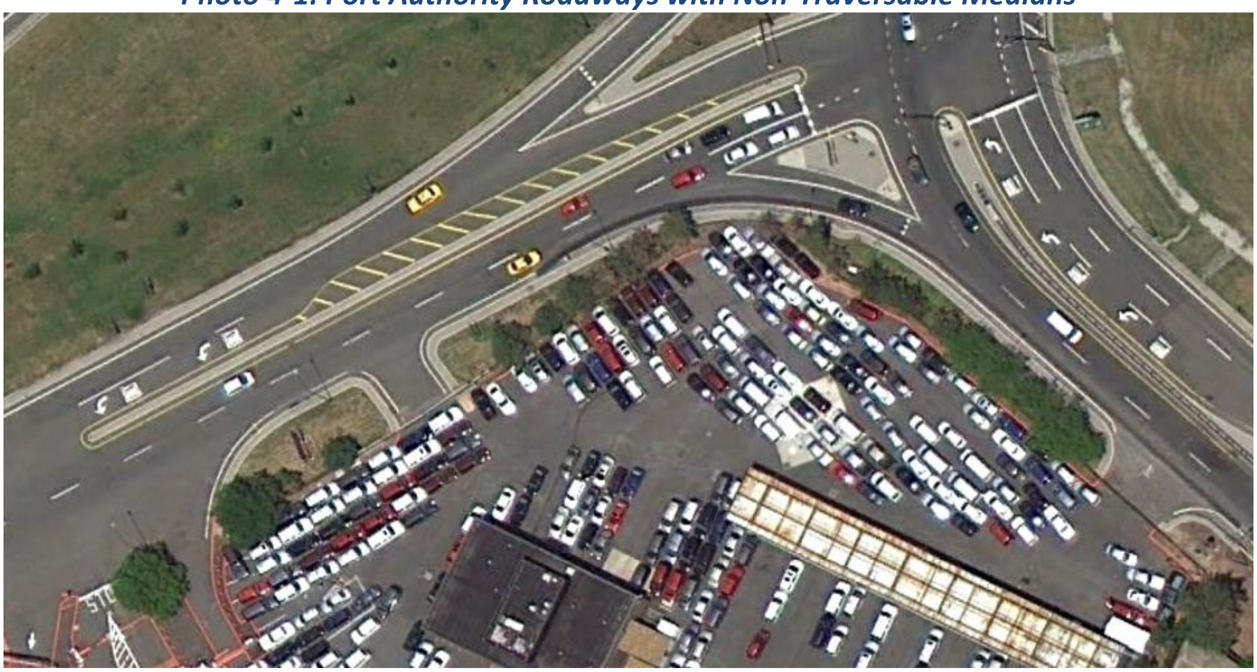

Photo source: Google Earth™ mapping service

[8] *Port Authority Bicycle Policy* issued by the Office of the Executive Director in Bulletin #10-05, dated March 29, 2010

Left-turning vehicles account for nearly three-quarters (74 percent) of all access-related crashes. Allowing unrestricted left-turn movements to and from all access driveways increases the number of vehicular conflict points with other vehicles, pedestrians, and bicyclists. Non-traversable medians — with designated median openings to allow for left-turn and U-turn movements — offer the following advantages over the other types of roadway cross-sections:

- Vehicles traveling in opposite directions are physically separated, eliminating the propensity for head-on crashes.
- When properly designed, the physical space provided for the deceleration and storage of left-turning and U-turning vehicles occurs outside of the through traffic lanes. The resulting reduction in speed differential between the turning and through vehicles improves traffic operations and reduces the potential for crashes.
- At a full median opening, the width of the non-traversable median provides a refuge area for passenger cars making a two-stage left-turn from a side-street (i.e., crossing traffic approaching from the left, and then turning left and merging with traffic approaching from the right)[9] or traveling straight across the roadway.
- The number of left-turn conflicts with vehicles, pedestrians, and bicyclists is reduced.
- The non-traversable median provides a refuge area for pedestrians crossing the roadway at intersections. In addition, mid-block pedestrian crossings can be provided and signalized without interfering with traffic progression (i.e., by stopping traffic approaching from the left first, and then stopping traffic from the right).
- Locations for making left-turns and U-turns are clearly identifiable to the driver, thus reducing driver workload.
- Non-traversable medians reduce the frequency and severity of crashes as compared to both undivided roadways and roadways with Two-Way Left-Turn Lanes (TWLTLs).

A non-traversable median should be considered on Port Authority roadways that fall under any of the following categories[10]:

- All new multi-lane principal arterial and arterial roadways
- Existing multi-lane principal arterial and arterial roadways with Average Daily Traffic (ADT) in excess of 24,000 vehicles per day
- Roadways where aesthetic considerations are a high priority
- Multi-lane roadways with high levels of pedestrian activity
- High-crash locations or areas where limiting left-turns is desirable

[9] The median may not be sufficiently wide to provide a safe refuge outside the traveled way for longer vehicles, such as trucks, making these movements.
[10] Source: 2003 *Access Management Manual*.

4.4 Auxiliary Lanes (Left-Turn and Right-Turn Lanes)

Auxiliary lanes (i.e., exclusive left-turn lanes and right-turn lanes) are an effective means of limiting the speed differential between a turning vehicle and through traffic behind it. The addition of auxiliary lanes has been shown to provide a variety of traffic safety and operational benefits including the following:

- Reducing the number of conflicts and crashes (particularly rear-end, angle, and sideswipe crashes)
- Physically separating turning traffic and queues from through traffic
- Decreasing vehicular delay and increasing intersection capacity
- Providing an area for turning vehicles to decelerate outside of the through traffic lane(s)
- Providing greater operational flexibility (e.g., additional traffic signal phasing opportunities)

Additional guidance regarding left-turn and right-turn lanes is provided in *Chapters 11* and *12*, respectively.

4.5 Roadside Buffers and Clear Zones

Establishing a roadside buffer is fundamental to roadway design. In addition to providing physical space along the roadside for the recovery of errant vehicles (i.e., a clear zone), the roadside buffer also provides a variety of benefits. First, it provides the unobstructed sight lines necessary for drivers to see oncoming traffic when they are waiting to turn from intersecting roadways and driveways. Second, the roadside buffer provides space for the location of roadside guide signs and for the placement and maintenance of utilities. In addition, the roadside buffer also provides space for sidewalks or pedestrian pathways and can be used for snow storage. Additional guidance regarding roadside buffers is provided in *Chapter 10*.

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CHAPTER 5: UNSIGNALIZED DRIVEWAY SPACING

5.1 Overview

Driveways introduce conflicts and friction into the flow of traffic along a roadway. Vehicles entering and leaving the roadway often slow the movement of through traffic, and the difference in speeds between through traffic and turning traffic increases the potential for crashes. Before seeking a driveway on the primary roadway, the design team should consider the various property access strategies described in *Chapter 13* to provide for sufficient access. These strategies include providing access through use of the following:

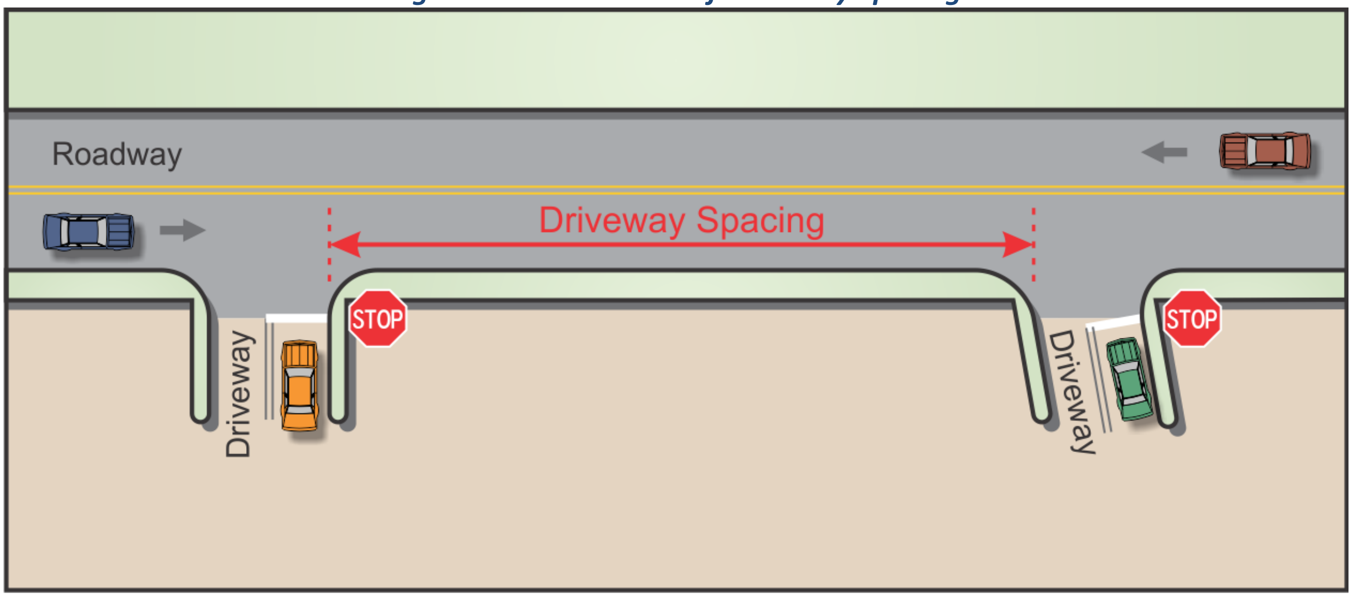
- Secondary roadways[11]
- Shared driveways and cross-access between leaseholds
- Frontage roads

Where a driveway is needed, its location should be selected to minimize its adverse effects on traffic flow and roadway safety. Increasing the spacing between the driveways – through proper planning of future driveways and closing or consolidating existing driveways – improves traffic flow and reduces the potential for crashes along the roadway by:

- Reducing the number of conflicts per mile
- Providing a greater distance for motorists to anticipate and recover from turning maneuvers
- Providing opportunities for the construction of acceleration lanes, deceleration lanes, or exclusive left-turn or right-turn lanes

As shown in *Figure 5-1*, driveway spacing is measured from the nearest edges of adjacent driveways.

Figure 5-1: Illustration of Driveway Spacing



[11] As defined in these *Guidelines*, a "secondary roadway" is one that has a lower access classification than the intersecting primary roadway (see *Chapter 3*, Table 3-1).

Each of these strategies is addressed in *Chapter 13* and should be considered. The intent of each strategy is to provide *reasonable access* for a particular property, or properties, such that the resulting access configuration conforms to the access management guidelines described in this document.

5.2 Guidelines

The spacing guidelines for unsignalized driveways vary by access classification. The spacing guidelines for principal arterial, arterial, and collector roadways are different than the spacing guidelines for local roads and private roads open for public travel. Both sets of guidelines are based on the posted speed of the street where the driveway would be located. The 85th percentile speed may be used in place of the posted speed if an engineering study that supports the use of the 85th percentile speed over the posted speed is completed and approved by Port Authority Traffic Engineering. In addition, if a roadway at a Port Authority facility does not have a posted speed, then the 85th percentile travel speed should be used.

The spacing guidelines presented below shall be applied using engineering judgment, with consideration given to site-specific features, which may result in the shifting of a driveway location to achieve safer and more efficient operations.

5.2.1 Principal Arterial, Arterial, and Collector Roads

The driveway spacing distances for principal arterial, arterial, and collector roadways are given in *Table 5-1*. The Desirable Driveway Spacing distances should be used. These distances are based on whether the roadway is divided (i.e., has a non-traversable median) or undivided (i.e., no median), as shown in *Figure 5-2*. Under constrained conditions, potential driveway locations may be limited by the existing physical features of the built and natural environments.

Where the Desirable Driveway Spacing distances shown in *Table 5-1* cannot be achieved, other access strategies are needed (see *Chapter 13*), or a design exception is needed (see *Chapter 14*).

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Table 5-1: Unsignalized Driveway Spacing Distances for Principal Arterial, Arterial, and Collector Roadways

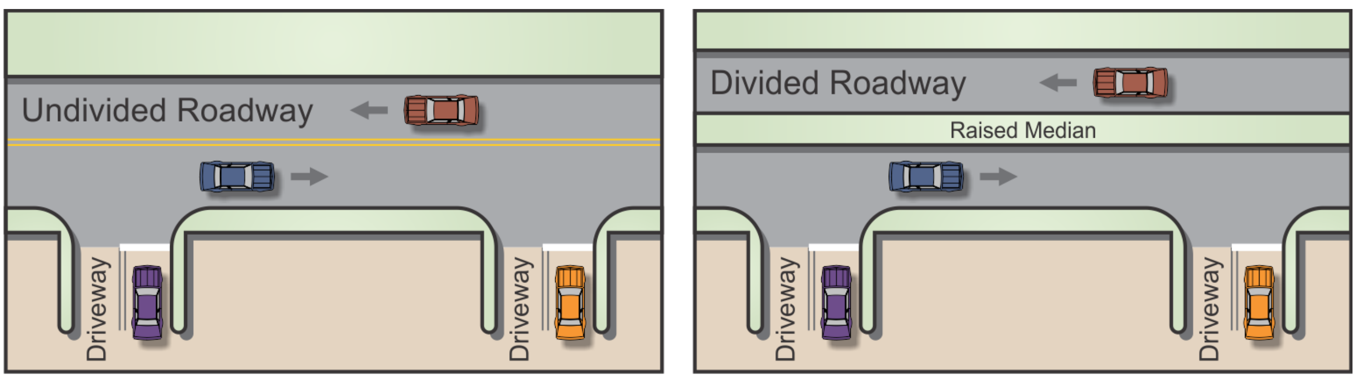
Posted Speed[1] (mph)	Desirable Driveway Spacing[2]		Minimum Driveway Spacing[3] (feet)
	Undivided Roadways (feet)	Divided Roadways (feet)	
20	260	245	115
25	370	340	155
30	500	450	200
35	640	570	250
40	790	700	305
45	950	835	360
50	1,140	995	425
55	1,340	1,165	495

1: The 85th percentile speed may be used in place of the posted speed if an engineering study that supports the use of the 85th percentile speed over the posted speed is completed and approved by Port Authority Traffic Engineering.

2: Desirable Driveway Spacing is based on superimposing the desirable corner clearance footprints for unsignalized intersections for the corresponding posted speed. Source: V. Stover and F. Koepke, *Transportation and Land Development, 2nd Edition*, 2002.

3: Minimum Driveway Spacing is based on AASHTO Stopping Sight Distance for the corresponding posted speed. Source: Adapted from Table 3-1, AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011, p. 3-4.

Figure 5-2: Comparison of Undivided and Divided Roadway Cross-Sections



5.2.2 Local Roads and Private Roads Open for Public Travel

The driveway spacing on local roads and private roads open for public travel are given in *Table 5-2*. The Desirable Driveway Spacing should be used. The Minimum Driveway Spacing distances are based on the Right-Turn Conflict Overlap (RTCO) concept[12].

Where the desirable driveway spacing distances shown in *Table 5-2* cannot be achieved, other access strategies are needed (see *Chapter 13*), or a design exception is needed (see *Chapter 14*).

Table 5-2: Unsignalized Driveway Spacing Distances for Local Roads and Private Roads Open for Public Travel

Posted Speed[1] (mph)	Desirable Driveway Spacing[2] (feet)	Minimum Driveway Spacing[3] (feet)
20	115	85
25	155	105
30	200	125
35	250	150
40	305	185
45	360	230

1: The 85th percentile speed may be used in place of the posted speed if an engineering study that supports the use of the 85th percentile speed over the posted speed is completed and approved by Port Authority Traffic Engineering.

2: Desirable Driveway Spacing is based on AASHTO Stopping Sight Distances. Source: Adapted from Table 3-1, AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011, p. 3-4.

3: Minimum Driveway Spacing is based on New Jersey Department of Transportation "Right-Turn Conflict Overlap". Source: Adapted from NJDOT, *New Jersey Highway Access Management Code*, 1990, p. 19.

[12] The Right-Turn Conflict Overlap (RTCO) distance is based on a driver (Driver "A") departing a driveway and accelerating away from another driver (Driver "B") who is approaching that driveway in the same direction. Rather than coming to a complete stop, Driver "B" must only decelerate to avoid a collision with Driver "A". The RTCO distance is the distance required to avoid this collision. However, if Driver "A" stalls upon exiting the driveway, a crash could occur due to insufficient stopping distance for Driver "B" (unless a shoulder or vacant adjacent lane exists to allow Driver "B" to change lanes and avoid a collision).

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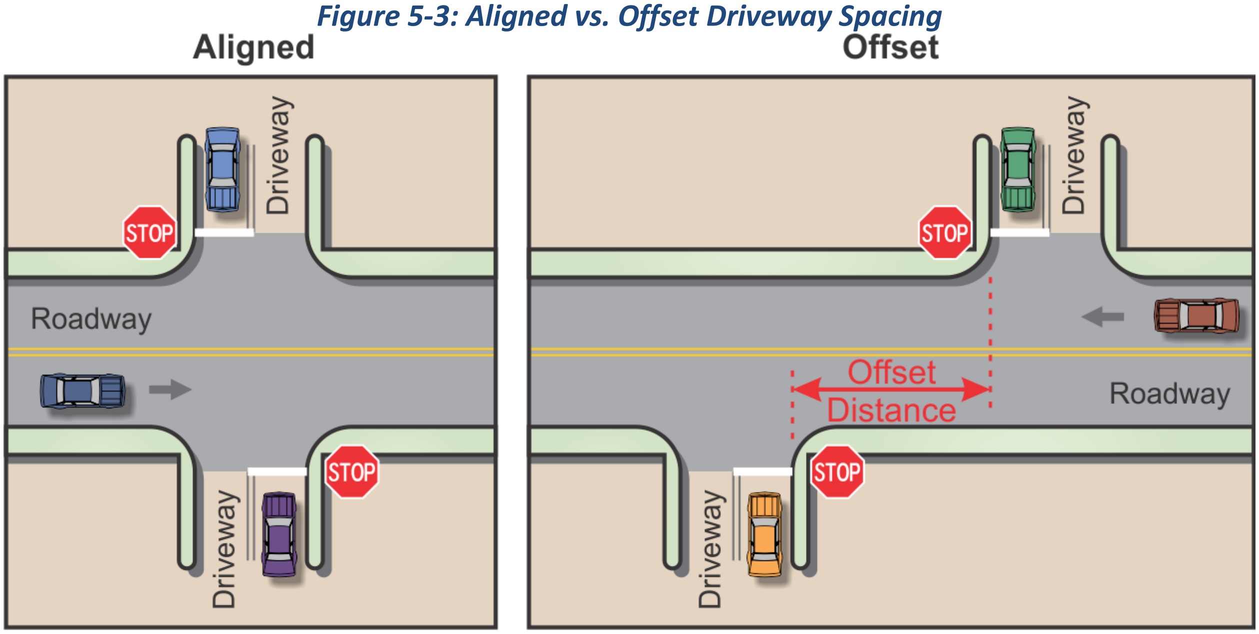
5.2.3 Additional Guidelines

The following additional guidelines apply to driveways on roadways of all access classifications:

- On undivided highways, driveways on opposite sides of the roadway should be aligned. Where this is not possible, the driveways should be offset by at least 200 feet (see *Figure 5-3*). One purpose of the offset is to separate the conflict points associated with each driveway. This is particularly important for conflicts associated with opposing left-turn movements from the roadway into the driveways, where the queue from the left-turn movement at one driveway may block the opposing left-turn into the other driveway. Further, the offset spacing distance should be increased where operational analysis of the driveways reveals a need for greater spacing (e.g., due to a high percentage of trucks, high turning movement volumes at the driveways, length of queues, etc.).

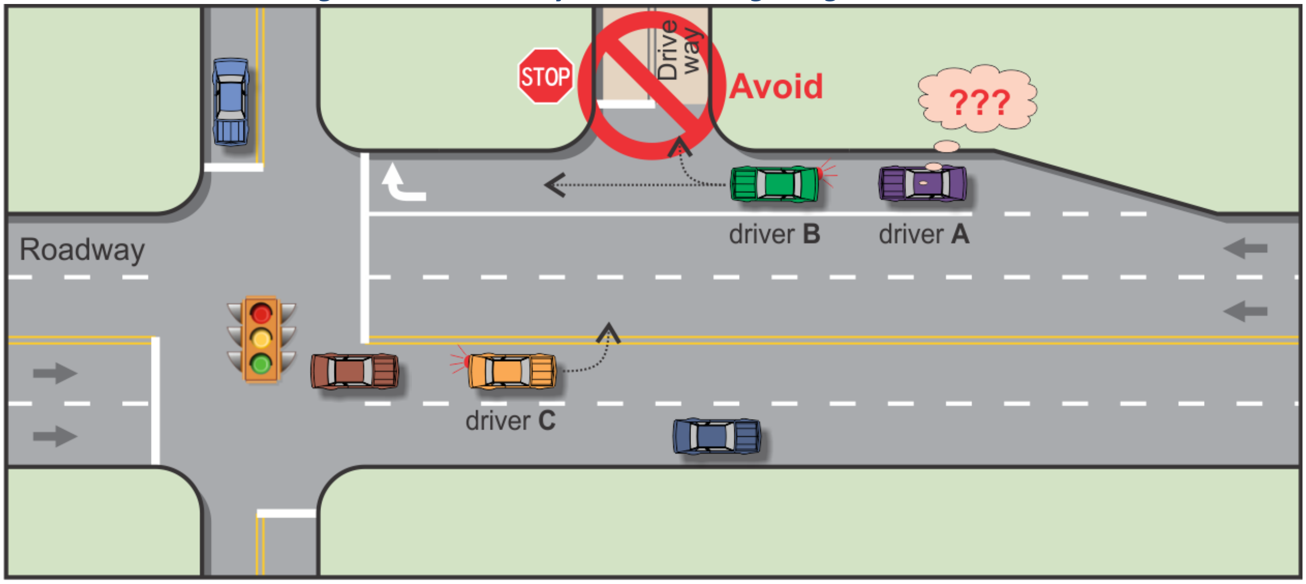
Figure 5-3: Aligned vs. Offset Driveway Spacing



- Driveways should be avoided along an acceleration, deceleration, or exclusive right-turn or left-turn lane (see example in *Figure 5-4*). One purpose of this guideline is to avoid violating driver expectancy. As shown in *Figure 5-4*, Driver "A" is following Driver "B" who has a right-turn signal on. Driver "A" may expect Driver "B" to turn right at the signalized intersection, while Driver "B" may intend to make a right-turn into the driveway. This confusion increases the potential for a crash.

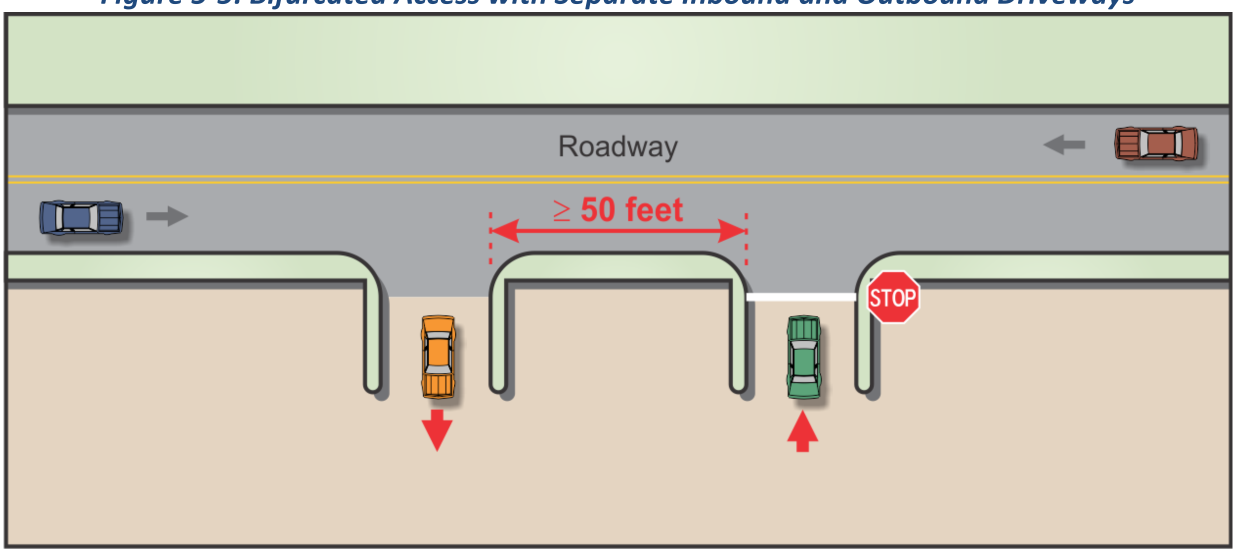
  In addition, avoiding driveways along right-turn lanes reduces the potential for a driver traveling in the opposite direction to make a left-turn into the driveway. A driver stopped and waiting to turn left into the driveway (through on-coming traffic in the opposite direction) often generates unexpected delays and queues that may back up through the signalized intersection. As shown in *Figure 5-4*, due to the proximity of the driveway to the signalized intersection, vehicles following Driver "C" will need to slow or stop unexpectedly while Driver "C" waits to turn left into the driveway. The resulting vehicle queues may spill back into the signalized intersection. This confusion also increases the potential for a crash. Similarly, a left-turn egress movement from the driveway onto the roadway may be blocked by a queue of vehicles waiting at the signal. These conflicting movements result in operational problems. (See guidance regarding functional area and intersection corner clearance in *Chapter 6*.)

Figure 5-4: Driveway Located Along a Right-Turn Lane



- An access may be bifurcated with separate driveways for ingress and egress, thereby separating the conflict points associated with the ingress and egress movements. Wherever possible, the distance between such driveways should be at least 50 feet (see *Figure 5-5*). The spacing distance should be increased where operational analysis of the driveways reveals a need for greater spacing (e.g., due to a high percentage of trucks, high turning movement volumes at the driveways, etc.).

Figure 5-5: Bifurcated Access with Separate Inbound and Outbound Driveways



- Even where sufficient frontage exists to provide multiple driveways and meet the spacing criteria shown in *Tables 5-1* and *5-2*, the number of driveways should be minimized. As illustrated in *Figure 5-6*, even though there is sufficient frontage for the four driveways shown, fewer may be adequate and more advantageous. Instead of each of the four sites having its own driveway, these sites may be accessed via two shared driveways, as long as each driveway is designed to provide enough capacity and safe access onto the abutting roadway.

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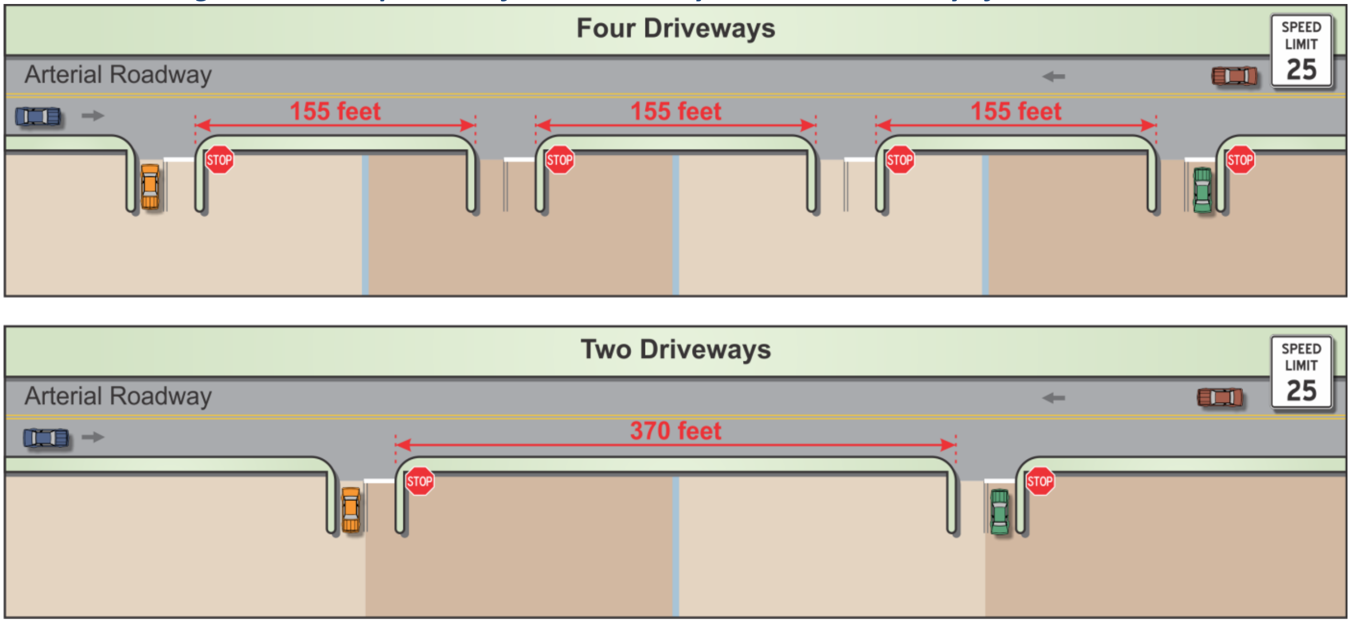
Figure 5-6: Comparison of Two Driveways vs. Four Driveways for Site-Access



- Property access should be limited to designated driveways. Continuous unrestricted access along a property frontage (i.e., an open frontage as in *Photo 5-1*) should not be allowed. This guideline not only decreases the number of potential conflict points but also minimizes driver confusion and resulting accidents.

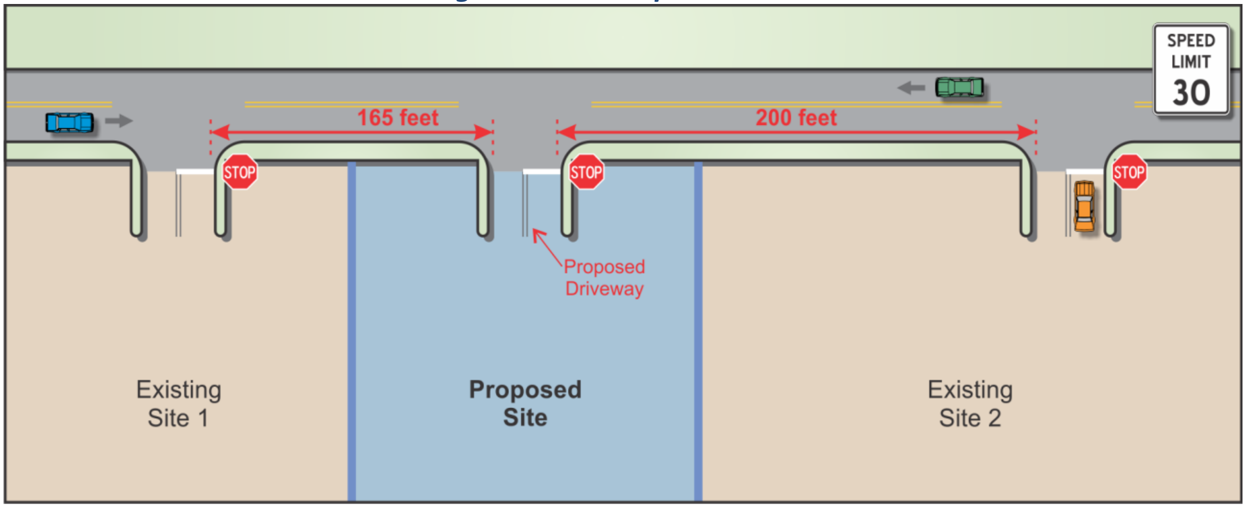
Photo 5-1: Continuous Access Along a Property Frontage

Source: J.L. Gattis

5.3 Example Calculation

Given: An undivided arterial roadway has a posted speed of 30 mph (see *Figure 5-7*). A site is proposed for development between two existing sites. The distances from the proposed driveway to each of the two existing driveways are shown in *Figure 5-7*.

Figure 5-7: Example Problem



Problem: Identify whether the unsignalized driveway spacing guidelines can be met for a driveway that is planned to serve the proposed site shown in *Figure 5-7*.

Solution: For an arterial roadway, refer to *Table 5-1* and identify the Desirable Driveway Spacing corresponding to an undivided roadway with a posted speed of 30 mph, as shown below.

Posted Speed (mph)	Desirable Driveway Spacing		Minimum Driveway Spacing (feet)
	Undivided Roadways (feet)	Divided Roadways (feet)	
20	260	245	115
25	370	340	155
30	**500**	450	200
35	640	570	250

As shown in Table 5-1, the Desirable Driveway Spacing is 500 feet. However, as shown in *Figure 5-7*, this spacing cannot be achieved given the existing spacing to the two driveways serving the adjacent properties. Therefore, other property access strategies would be needed (see Chapter 13), or a design exception is needed for the proposed driveway location (see Chapter 14).

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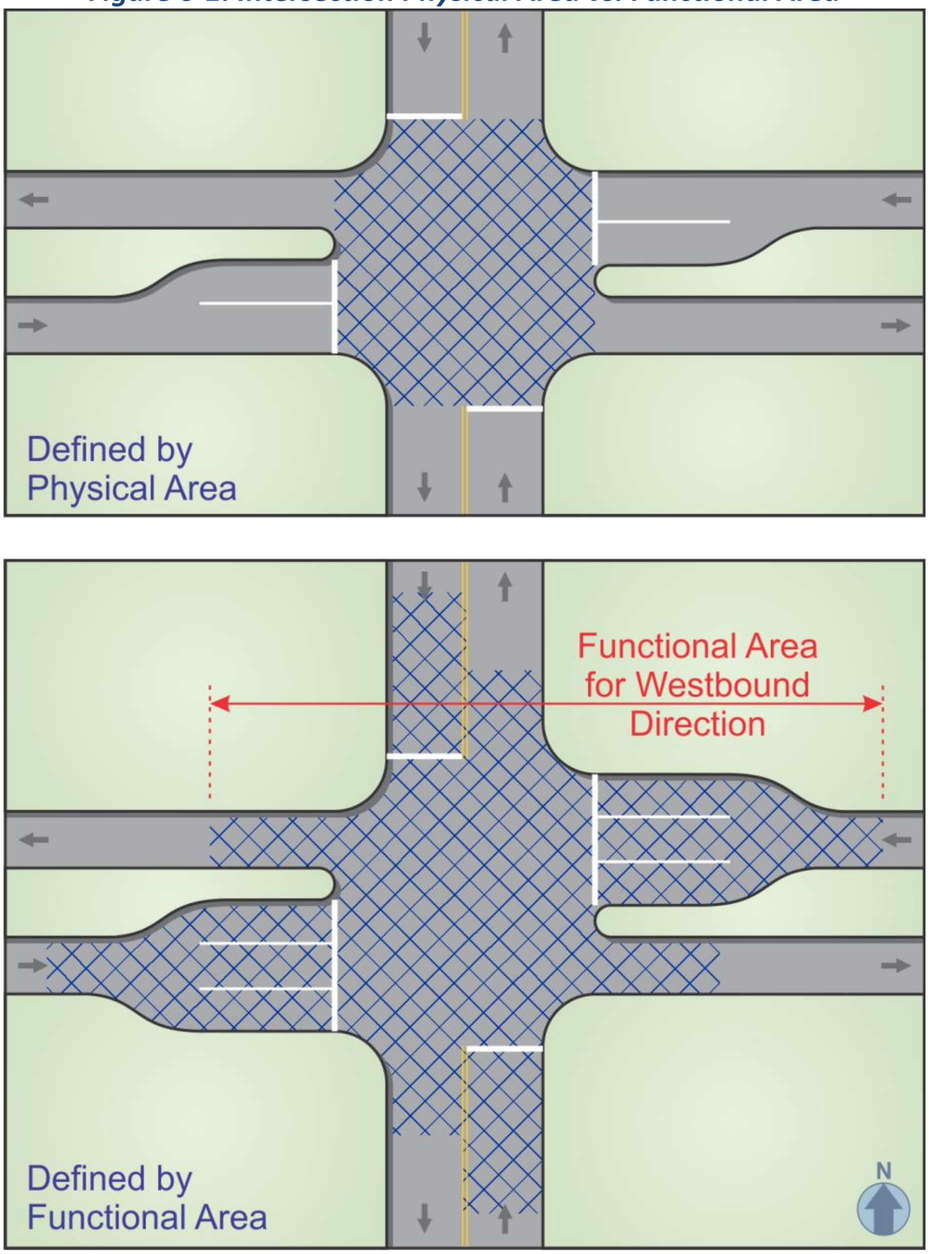
CHAPTER 6: INTERSECTION CORNER CLEARANCE

6.1 Overview

Protecting the functional integrity of intersections along Port Authority roadways is extremely important, including intersections with both other Port Authority roadways and roadways under the jurisdiction of the state, county, or local municipality. One strategy to help accomplish this is to locate driveways outside of the *functional area* of an intersection. As shown in *Figure 6-1* and described previously, the functional area extends beyond the physical intersection of the two roadways to include the upstream approaches where deceleration, maneuvering and queuing take place, as well as the downstream departure area beyond the intersection where driveways could introduce conflicts and generate queues backing up through the intersection.

Figure 6-1: Intersection Physical Area vs. Functional Area



Source: Adapted from Figure 9-1, AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011, p. 9-3.

The functional area of an intersection is defined by clearance distances on both the upstream approach and the downstream departure leg in the vicinity of the physical intersection. Driveways should be located beyond the Upstream Clearance Distance (UCD), shown in *Figure 6-2*, and the Downstream Clearance Distance (DCD), shown in *Figure 6-3*. These distances shall be computed using the procedures described in this chapter.

Figure 6-2: Upstream Clearance Distance (UCD) for Westbound Direction

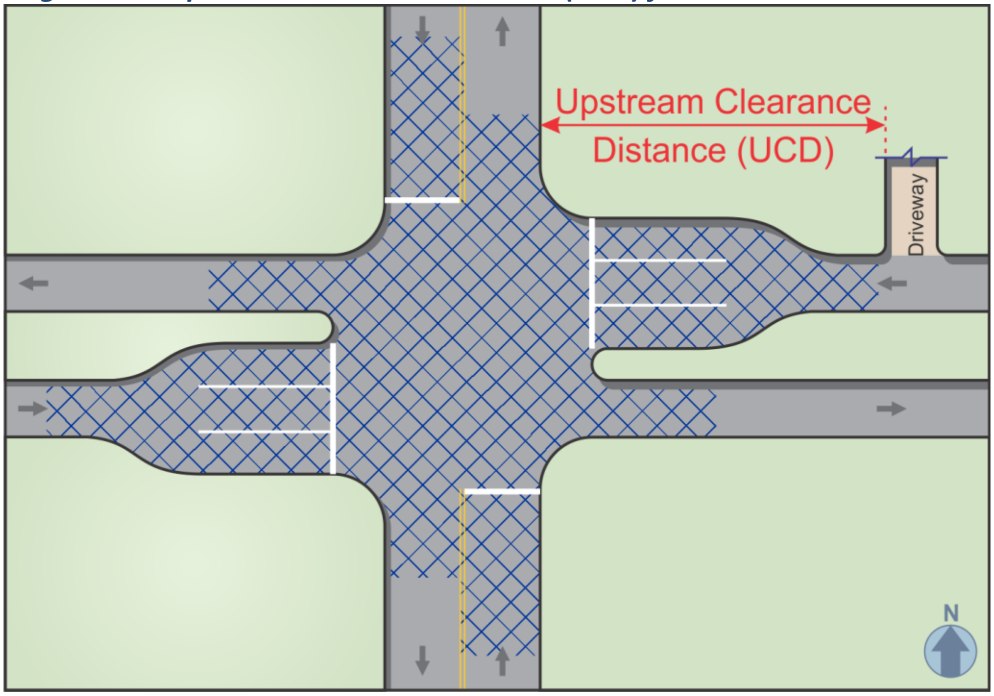
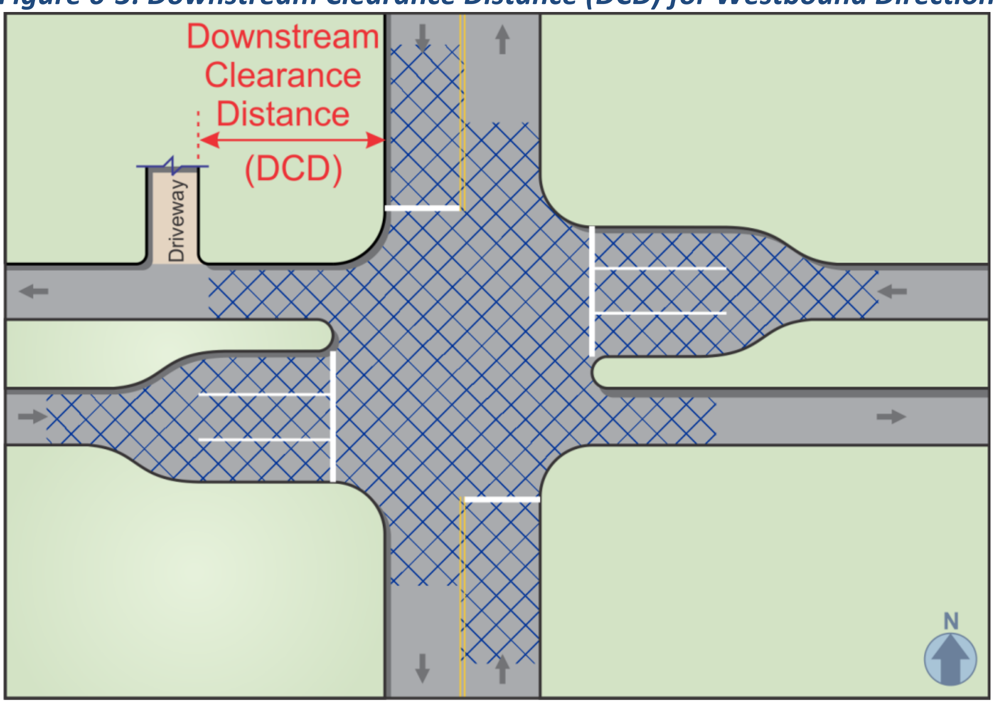


Figure 6-3: Downstream Clearance Distance (DCD) for Westbound Direction



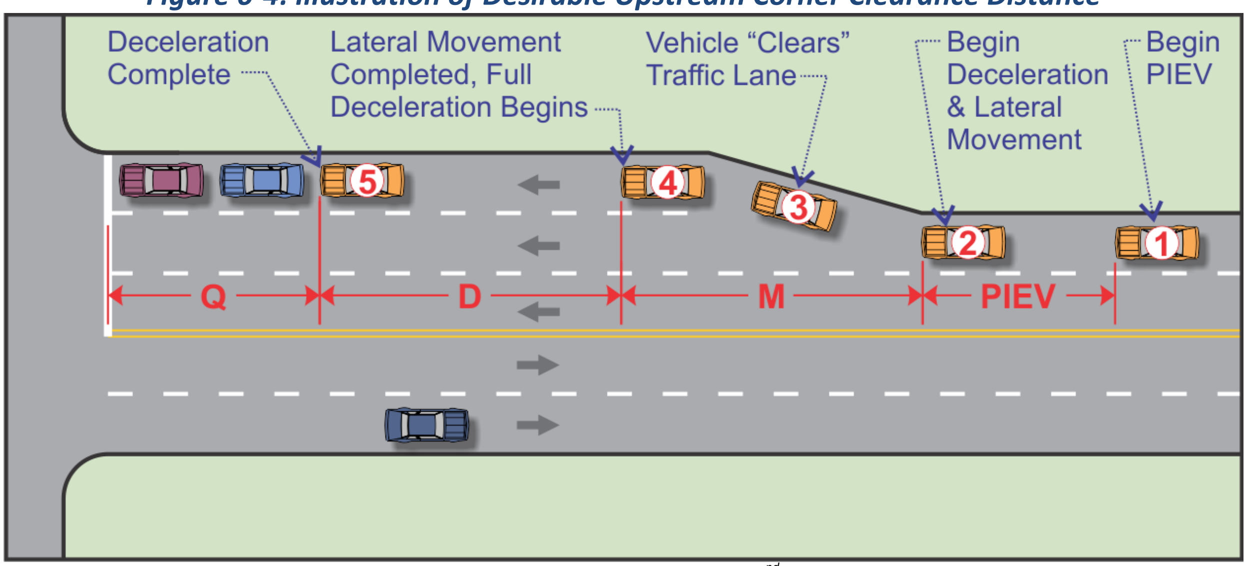
6.2 Guidelines

6.2.1 Principal Arterial, Arterial, and Collector Roads

Principal arterial, arterial, and collector roads have different corner clearance criteria than local roads and private roads open for public travel. The calculation of the desirable UCD for principal arterial, arterial, and collector roadways is the sum of the distances shown in *Figure 6-4*. The figure illustrates the movements necessary for a driver traveling along a roadway (from right to left) to recognize and prepare to turn at an upcoming intersection. The four stages required for the driver to be prepared to turn are depicted in terms of distances needed for each action. They include the following:

- **Perception, Identification, Evaluation, and Volition (PIEV) distance** – This is the total distance a driver needs to recognize and react to traffic activity at an upcoming intersection. The PIEV distance is also commonly referred to as the "perception-reaction" distance.
- **Maneuver (M) distance** – This is the distance required for a driver to maneuver laterally into the desired lane and begin decelerating.
- **Deceleration (D) distance** – This is the distance required for a driver to decelerate to the back of a standing queue.
- **Queue (Q) distance** – This distance is the length of the vehicle queue on the intersection approach. The length of the queue should be calculated using standard intersection capacity analysis software (e.g., Highway Capacity Software) based on the type of intersection traffic control (signalized, all-way stop-control, two-way stop-control, or roundabout) and the future traffic volumes from the project's forecast year of full build-out[13].

Figure 6-4: Illustration of Desirable Upstream Corner Clearance Distance



Source: Adapted from Stover, V., and F. Koepke, *Transportation and Land Development, 2nd Edition*, 2002, p. 5-42.

The sum of these distances (i.e., PIEV + M + D + Q) is the desirable UCD for principal arterial, arterial, and collector roadways. *Table 6-1* identifies the combined distances for "PIEV + M + D" for the corresponding posted speed. The queue distance (Q) is calculated based on site-specific conditions and added to the "PIEV + M + D" distance.

[13] A horizon year beyond the year of full build-out may be used based on engineering judgment and with approval from a Port Authority Traffic Engineering Principal.

Table 6-1: PIEV + M + D + Q Distances

Posted Speed[1] (mph)	PIEV + M + D Distance (feet)	Q Distance (feet)
20	130	Calculate based on site-specific conditions.
25	185	
30	250	
35	320	
40	395	
45	475	
50	570	

1: The 85^{th} percentile speed may be used in place of the posted speed if an engineering study that supports the use of the 85^{th} percentile speed over the posted speed is completed and approved by Port Authority Traffic Engineering.

Driveways on principal arterials, arterials, and collectors should be located outside of the functional area of intersections, as defined by the UCD and the DCD. These distances are determined by following the guidance provided in *Table 6-2*. The criteria for these roadways are also specified relative to whether the driveway is located upstream or downstream of the intersection, and whether the roadway has a non-traversable median.

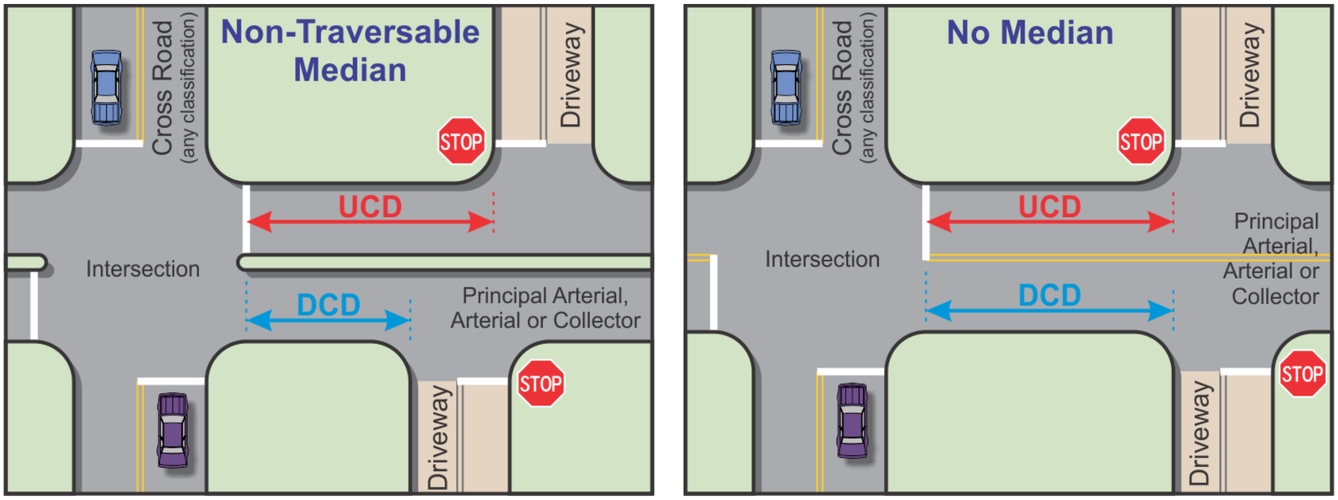
Table 6-2: Port Authority Corner Clearance Guidelines for Principal Arterial, Arterial, and Collectors Roads

Median Control?	Upstream Clearance Distance (UCD)		Downstream Clearance Distance (DCD)	
	Desirable[1]	Minimum[3]	Desirable	Minimum
Non-traversable median	PIEV + M + D distance + 85^{th} percentile queue length on approach[2] (See ***Table 6-1*** for "PIEV + M + D" distances, based on posted speed.)	See ***Table 5-1:*** Use **minimum** unsignalized driveway spacing distance	See ***Table 5-1:*** Use **desirable** unsignalized driveway spacing distance	See ***Table 5-1:*** Use **minimum** unsignalized driveway spacing distance
No median, or traversable median			DCD equals the UCD for traffic traveling in the opposite direction on the same leg of the intersection	

1. The *desirable UCD* is measured between the nearest edge of the driveway and the stop bar on the intersection approach (see *Figure 6-6*).
2. The 85^{th} percentile queue length represents the distance that would not be exceeded by a queue of vehicles 85 percent of the time during the analysis period. For major street approaches to two-way stop-controlled intersections where only the intersecting minor street is stop-controlled, queue length=0.
3. The *minimum UCD* is measured from the nearest edge of the driveway to the edge of the cross road, in accordance with the measurement for the unsignalized driveway spacing guidelines (see *Figure 6-6*).

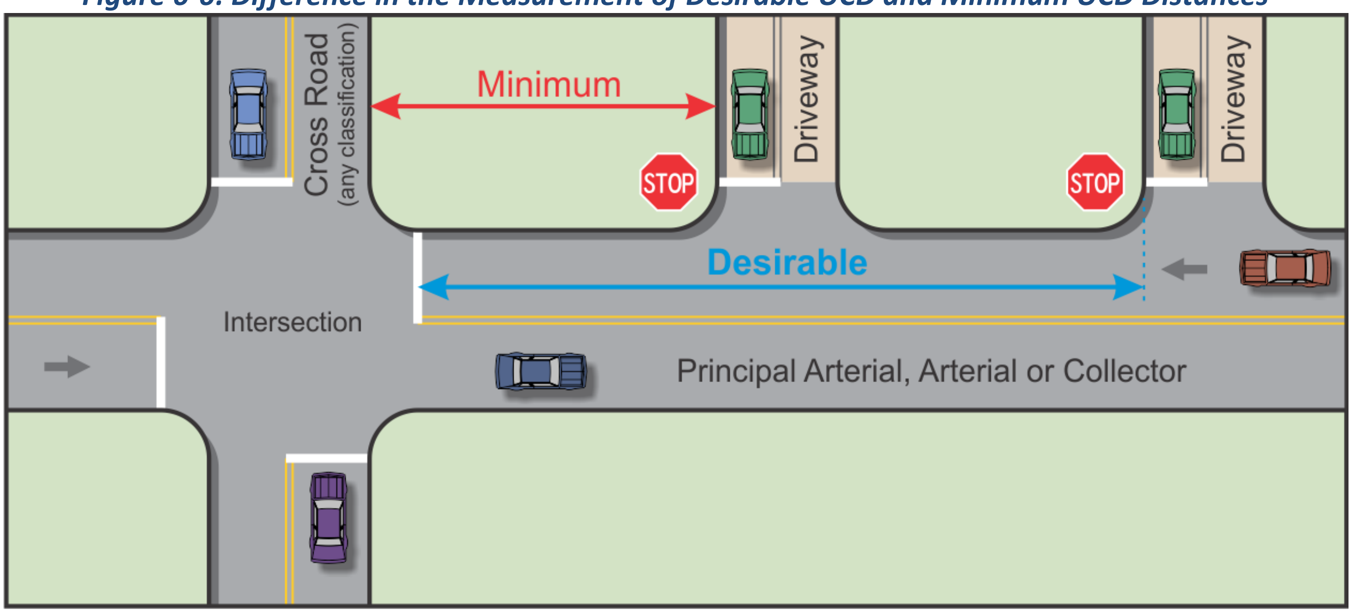
Figure 6-5 illustrates the difference in the desirable Upstream Clearance Distances and desirable Downstream Clearance Distances for roadways with, and without, a non-traversable median. As shown in *Figure 6-5*, for the "no median" case, the desirable DCD equals the desirable UCD for traffic traveling in the opposite direction. In contrast, for the median case, the desirable DCD is less than the desirable UCD. This is because left-turn conflicts at the driveways have been eliminated by the presence of the non-traversable median.

Figure 6-5: Comparison of Desirable UCD and DCD for Roadways With, and Without, a Non-Traversable Median



Furthermore, as noted in *Table 6-2*, and illustrated in *Figure 6-6*, the *desirable UCD* is measured from the nearest edge of the driveway *to the stop-bar on the intersection approach*. In contrast, the *minimum UCD* is measured from the nearest edge of the driveway *to the edge of the cross road*, in accordance with the measurement for the unsignalized driveway spacing guidelines described in *Figure 5-1*.

Figure 6-6: Difference in the Measurement of Desirable UCD and Minimum UCD Distances

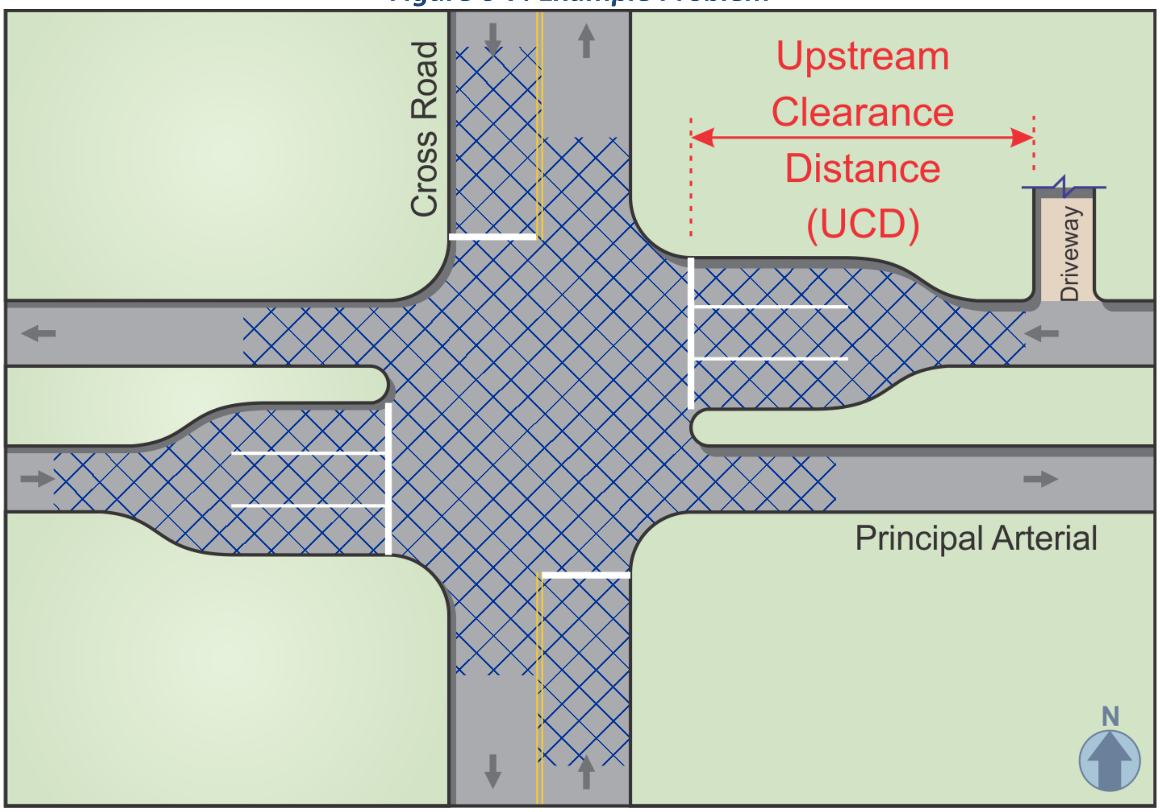


6.2.2 Example Calculation: Upstream Clearance Distance for Arterial Roadway

Given:

- A principal arterial roadway with a non-traversable median and a posted speed of 40 mph (see *Figure 6-7*).
- The principal arterial is intersected by a cross road. The intersection operates under traffic signal control. The 85th percentile queue length on the westbound approach to the cross road intersection is 175 feet (calculated using Highway Capacity Software).

Figure 6-7: Example Problem



Problem: Given the parameters above, calculate the desirable UCD for a site-access driveway planned to be located on the westbound approach of the principal arterial, east of the intersection with the cross road.

Solution:

1) See guidance in *Table 6-2* for a principal arterial roadway with a non-traversable median: **Desirable UCD** = (PIEV + M + D distance) + 85th percentile queue length on approach

2) Refer to *Table 6-1* for PIEV + M + D distance at 40 mph, as shown below

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Posted Speed (mph)	PIEV + M + D Distance (feet)	Q Distance (feet)
35	320	Calculate based on site-specific conditions.
40	**395**	
45	475	

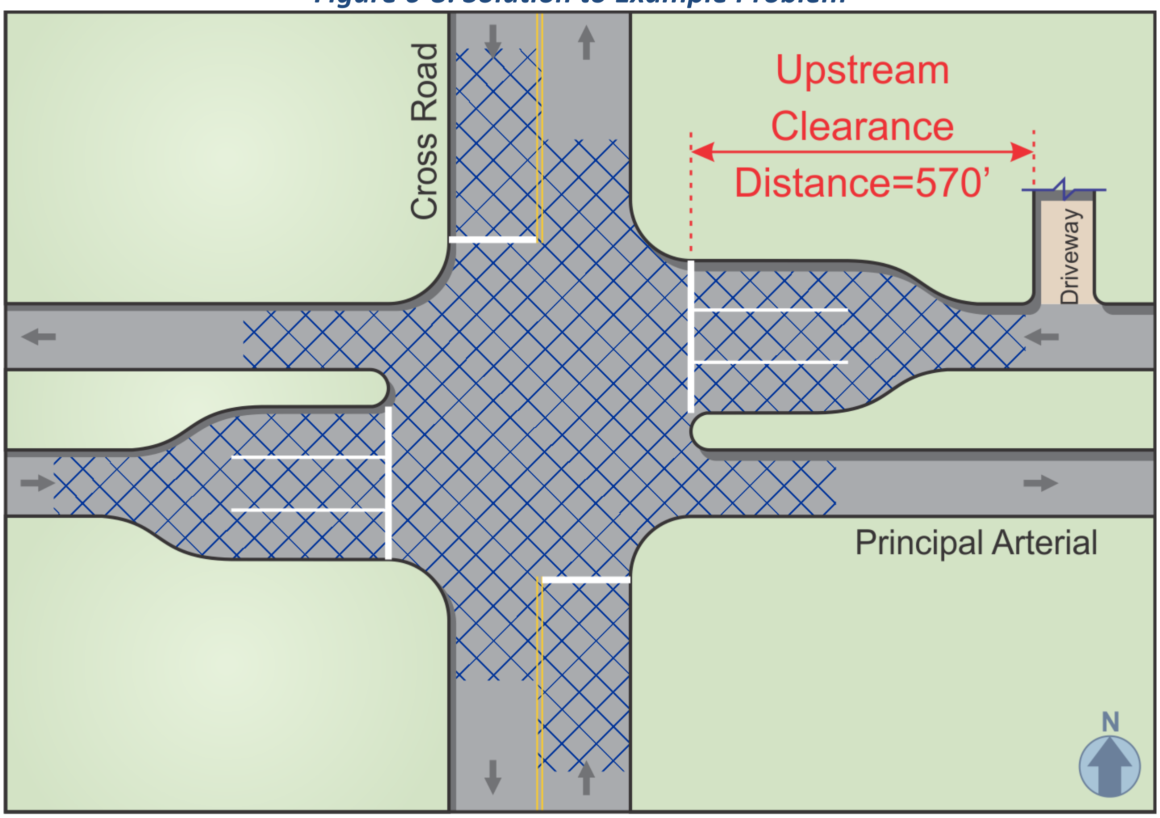
3) PIEV + M + D distance = 395 feet

4) 85th percentile queue length = 175 feet (given)

5) **Desirable UCD** = 395 feet + 175 feet = 570 feet (as measured from the nearest edge of driveway to the stop bar)

Therefore, the driveway should be located no less than 570 feet east of the stop bar on the westbound approach to the intersection, as shown in *Figure 6-8*.

Figure 6-8: Solution to Example Problem



6.2.3 Local Roads and Private Roads Open for Public Travel

Driveways on local roads and private roads open for public travel should be located outside the functional area of intersections, as defined by the UCD and DCD. In these cases, the desirable UCD and DCD distances are determined following the guidance provided in *Table 6-3*.

Table 6-3: Port Authority Corner Clearance Guidelines for Local Roads and Private Roads Open to Public Travel

Upstream Clearance Distance (UCD)		Downstream Clearance Distance (DCD)	
Desirable[1]	Minimum[3]	Desirable	Minimum
Greater of: 1) **Desirable** unsignalized driveway spacing distance (see *Table 5-2*) *or* 2) **95^{th} percentile queue length**[2]	See ***Table 5-2:*** Use **minimum** unsignalized driveway spacing distance	See ***Table 5-2:*** Use **desirable** unsignalized driveway spacing distance	See ***Table 5-2:*** Use **minimum** unsignalized driveway spacing distance

1. The *desirable UCD* is measured between the nearest edge of the driveway and the stop bar on the intersection approach.
2. The 95^{th} percentile queue length represents the distance that would not be exceeded by a queue of vehicles 95 percent of the time during the analysis period. For major street approaches to two-way stop-controlled intersections where only the intersecting minor street is stop-controlled, queue length=0.
3. The *minimum UCD* is measured from the nearest edge of the driveway to the edge of the cross road, in accordance with the measurement for the unsignalized driveway spacing guidelines.

6.2.4 Additional Guidance

In certain cases, limited frontage for the subject property may prevent the desirable corner clearance distances shown in *Tables 6-2* and *6-3* from being achieved. In these cases, the property access strategies described in *Chapter 13* should be considered, or the proposed leasehold boundaries should be redrawn. If these options are not feasible, the spacing of the property's driveway from the intersection should be maximized, and a design exception is needed (see *Chapter 14*).

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CHAPTER 7: TRAFFIC SIGNAL SPACING

7.1 Overview

The proper spacing of traffic signals – in terms of frequency[14] and uniformity[15] – is one of the most important and basic access management techniques because of the effects traffic signals have on the traveling public. Properly-spaced traffic signals allow for the efficient progression of motor vehicle and pedestrian traffic, as well as providing an agency with greater flexibility in developing signal timing plans that can most effectively accommodate varying travel conditions (for example, fluctuations in volume during peak and off-peak periods).

Despite the benefits that traffic signals provide, the installation of a traffic signal is not always the best solution to the operational or safety issues at every intersection or driveway along a roadway. Closely-spaced or improperly-spaced traffic signals can result in frequent stops and unnecessary delays for motorists and pedestrians, as well as increased crash rates, increased fuel consumption, and excessive vehicular emissions.

Given the traffic operations, safety, and environmental implications related to the signalization of intersections, the decision to install a new traffic signal should involve a comprehensive examination of the land use and transportation context of the surrounding area from both planning and engineering perspectives, including such factors as:

- The Port Authority's desired traffic signal control strategy for the roadway or area
- The considerations outlined in the *Port Authority Intersection Signalization Procedures* document, specifically including whether or not the subject intersection meets the traffic signal warrants established in the *Manual on Uniform Traffic Control Devices* (*MUTCD*)
- The existing level of development on, as well as the build-out potential of, nearby properties
- The presence (or absence) of other traffic signals in the area
- The potential need for installation of traffic signals at nearby intersections in the future

7.2 Guidance – A Framework for Traffic Signal Installations at Port Authority Facilities

The guidance framework for determining the appropriate traffic signal spacing guideline to use for projects at Port Authority facilities incorporates:

- Procedures from the *Port Authority Intersection Signalization Procedures* document
- The scope and type of the Port Authority project (e.g., redevelopment program, TAA, etc.)
- An understanding of the Port Authority's desired signal control strategy for the location in question

Each of these parameters is included as part of a "decision tree" to help guide practitioners to the appropriate traffic signal spacing guideline for a particular project, if a traffic signal is warranted. Some background regarding these parameters is provided in the following sub-sections.

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[14] "Frequency" refers to the number of traffic signals for a given length of roadway and is sometimes referred to as "signal density." It is typically expressed as the number of signals per mile.

[15] "Uniformity" refers to the variation in the distances between individual traffic signals along a given length of roadway. It is desirable to minimize this variation and space the traffic signals at uniform distances. For example, suppose a two-mile segment of roadway requires four traffic signals (i.e., a signal density of two signals per mile). All things being equal, it is more desirable to space the signals at a uniform distance along the roadway (e.g., every ½ mile), rather than space them irregularly (e.g., 1 mile, ¼ mile, ½ mile, and ¼ mile).

7.2.1 Port Authority Intersection Signalization Procedures

The *Port Authority Intersection Signalization Procedures* is a Port Authority document describing the processes to be followed for the installation, modification, and removal of traffic signals, based on whether the requested action is initiated by the Port Authority, another public agency, or a private entity. The traffic signal spacing guidelines presented in this chapter incorporate, by reference, and build upon the procedures described in that document.

7.2.2 Scope and Type of Port Authority Projects

Each project within a Port Authority facility is unique in terms of its size and scope. For example, a Port Authority safety improvement project may focus on improvements to reduce crashes at a single intersection or driveway. At a broader scale, Tenant Alteration Applications are focused on the access and transportation needs for a specific site, with a scope that may include several adjacent roadways and intersections, abutting tenant leaseholds, and the immediate environs of the site. Further, large roadway improvement projects at Port Authority facilities may encompass improvements to dozens of individual intersections and driveways. At the highest level, Port Authority redevelopment projects involve broad planning-level efforts to reexamine the access and transportation needs of an entire facility, or large portion thereof. The traffic signal spacing guidelines presented in this chapter address these considerations.

The request for a traffic signal installation (or modification) shall be submitted to the Port Authority. Port Authority Traffic Engineering will review the request.

7.2.3 Port Authority Traffic Signal Control Strategies

The guidelines described in this chapter have been established in recognition that the Port Authority typically installs, maintains, and operates traffic signals in accordance with one of the following three primary signal control strategies[16]:

- Signal Control Strategy #1: Optimizing Vehicle Progression
- Signal Control Strategy #2: Managing Vehicle Queue Lengths to Prevent Spillback
- Signal Control Strategy #3: Managing Pedestrian Flow

Each of these signal control strategies applies a unique set of guidelines for the location of traffic signals at Port Authority facilities. The appropriate signal control strategy to be used in a particular area is determined by the Port Authority's Chief Traffic Engineer. Following a decision regarding the appropriate signal control strategy, the first step in determining the applicable traffic signal spacing guidelines is to use the decision tree in *Figure 7-1*.

The decision tree begins with a determination as to whether the subject location is part of a *Port Authority redevelopment program*. Under a redevelopment program, an entire Port Authority facility – or a significant portion thereof – is being considered for redevelopment. As such, the land uses, roadway alignments, and/or intersection locations at that facility are generally subject to major changes. As a result, there is typically a greater level of flexibility with respect to potential traffic signal locations and more opportunity to space traffic signals in accordance with the desired signal control strategy.

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[16] There may be other special signal control strategies used in particular locations at Port Authority facilities to address unique, site-specific operational or safety considerations.

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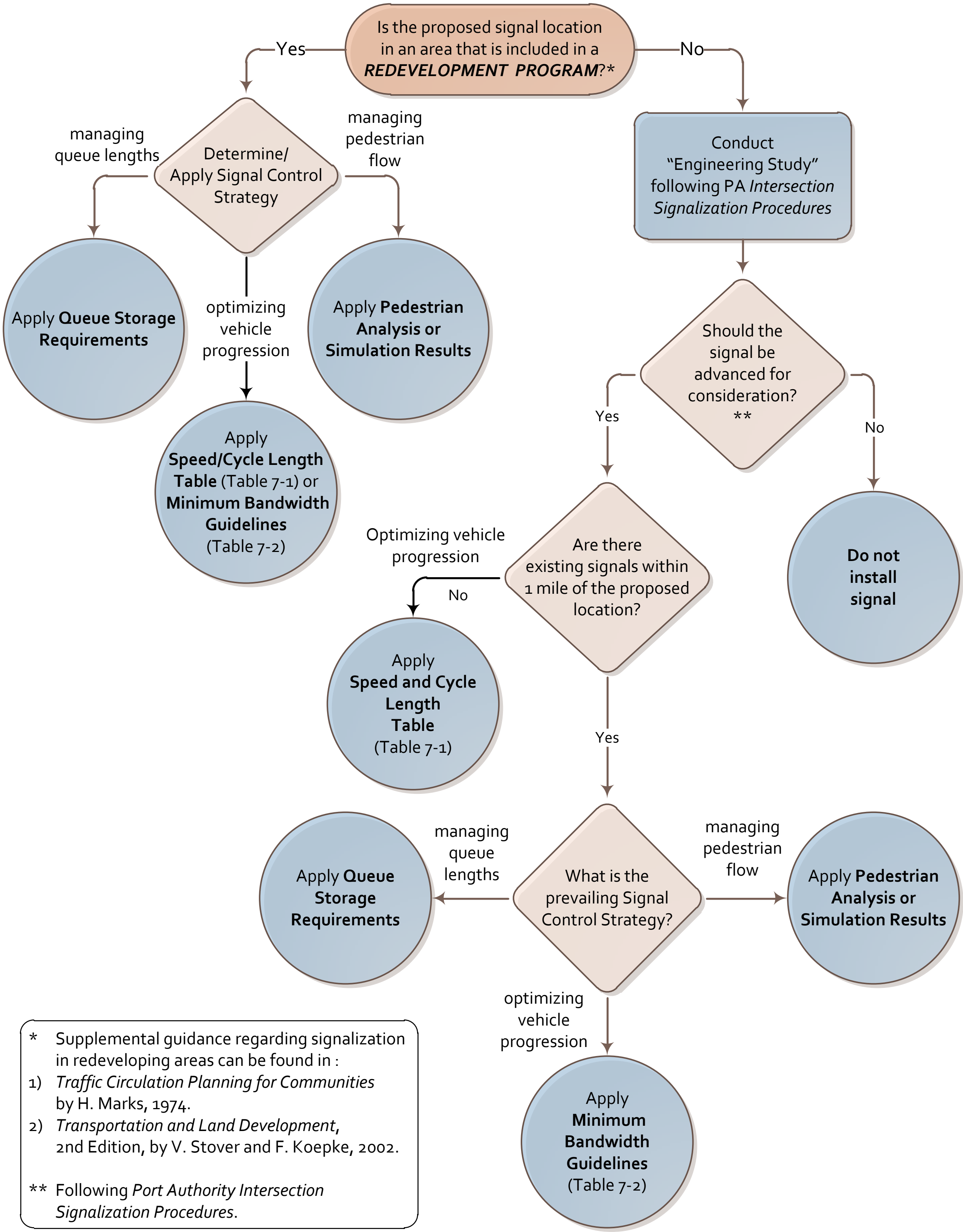
Conversely, many other Port Authority projects where traffic signal installations are considered – such as Tenant Alteration Applications and roadway improvement projects – are located in developed areas where properties already have been developed and roadway alignments and intersection locations already have been established. Under these circumstances, there is often less flexibility with respect to locating new traffic signals. Nevertheless, new traffic signals may still be installed, provided opportunities exist to change the operation of the existing traffic signals along the corridor (e.g., phasing sequences, timing patterns, and/or offsets) to provide for efficient traffic progression.

As shown in the decision tree, with non-redevelopment program projects, the "engineering study" described in the *Port Authority Intersection Signalization Procedures* should be applied first to determine whether a traffic signal is warranted. This engineering study involves a comprehensive examination of traffic safety and operations at the subject location, based on traffic volumes for peak and off-peak time periods, pedestrian activity, crash history, and other factors. The engineering study also includes a detailed analysis of the need for a traffic signal relative to the standard traffic signal warrants published in the *MUTCD*.

If the engineering study concludes that a traffic signal installation should be progressed, the spacing to other existing (or planned future) traffic signals along the intersecting corridors is then determined. Different traffic signal spacing guidelines will apply depending on whether existing traffic signals are located within one mile of the subject intersection.

In summary, the decision tree presents a framework for determining which traffic signal spacing guidelines are most appropriate, based on the type of project, the transportation and land use context of the project, and the Port Authority's desired signal control strategy. The specific traffic signal spacing guidelines are discussed below.

Figure 7-1: Traffic Signal Spacing Decision Tree



* Supplemental guidance regarding signalization in redeveloping areas can be found in :

1) *Traffic Circulation Planning for Communities* by H. Marks, 1974.
2) *Transportation and Land Development*, 2nd Edition, by V. Stover and F. Koepke, 2002.

** Following *Port Authority Intersection Signalization Procedures*.

7.3 Traffic Signal Spacing Guidelines

The following sub-sections detail the Port Authority guidelines for traffic signal spacing based on the three signal control strategies outlined above.

7.3.1 Guidelines for Signal Control Strategy #1: Optimizing Vehicle Progression

When the efficient progression of vehicular traffic along a corridor is the desired traffic signal control strategy, the land use context of the abutting roadside development is first taken into consideration. Separate traffic signal spacing guidelines have been established for:

1) Undeveloped and developing areas

2) Developed areas

Each of these areas is discussed below along with its associated guidelines to achieve vehicle progression when a new traffic signal is proposed.

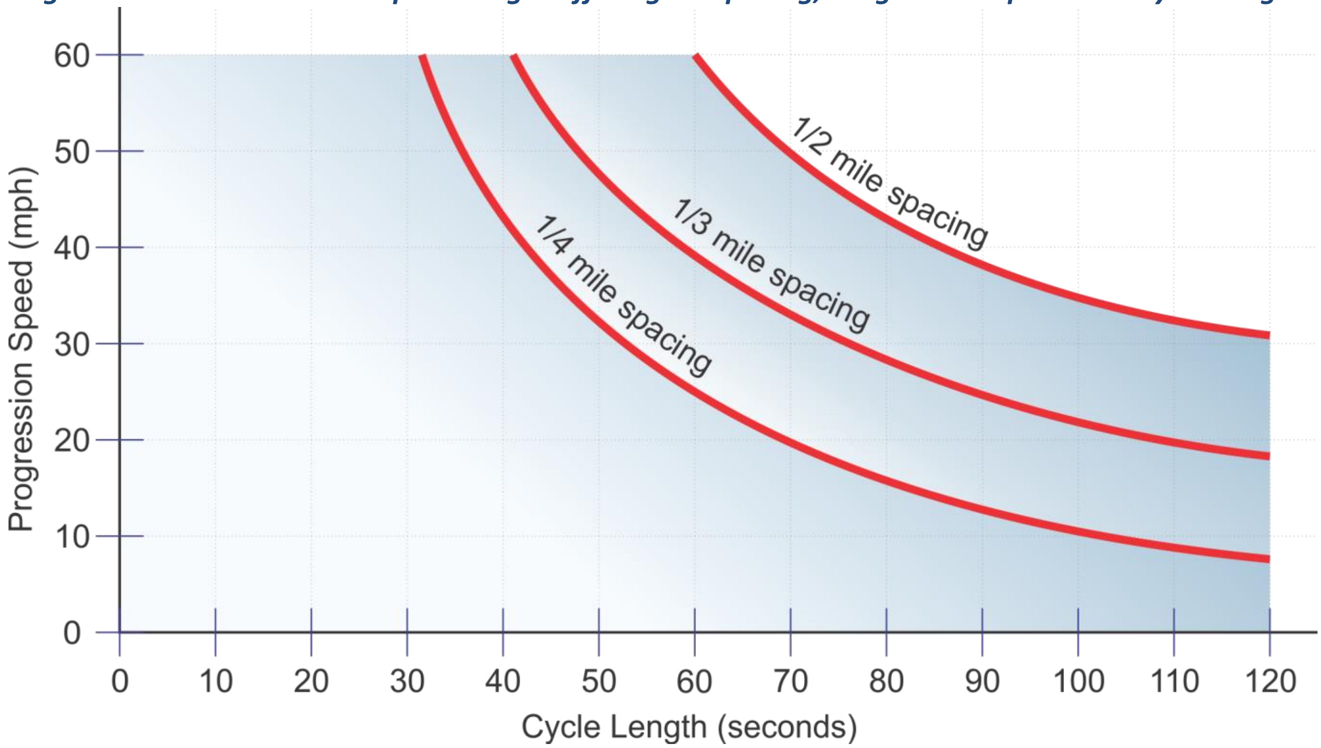
7.3.1.1 Guidelines for Undeveloped or Developing Areas

In both undeveloped and developing areas, there is typically greater flexibility for spacing traffic signals (relative to developed areas) because the spacing of intersections and driveways along a particular corridor has not yet been fully established. *Undeveloped areas* are characterized by: a) little to no roadside development, b) few (if any) intersecting driveways and roadways, c) right-of-way available for roadway improvements, and/or d) little to no pedestrian activity. *Developing areas* are those that are (or will be) undergoing changes related to roadside development activity. These areas are typically characterized by one or more of the following features: a) roadside development planned, imminent, or already taking place, b) a growing number of driveways and intersecting roadways, c) increasing pedestrian activity, and/or d) a need to consider transit. Under such conditions, it is generally easier to achieve ideal traffic signal spacing distances, as described below.

The progression speed for a corridor is primarily a function of both the traffic signal spacing along the corridor and the cycle length of the traffic signals along that corridor[17]. The fundamental relationships among traffic signal spacing, progression speed, and cycle length – which dictate the operation and performance of corridors with multiple signalized intersections – are illustrated in *Figure 7-2*. As the curves in *Figure 7-2* show, for a given cycle length, higher vehicle progression speeds can be achieved by increasing the distance between signals. Similarly, for a given cycle length, reducing the spacing between signals results in a reduction in the progression speed.

[17] Progression speed is also influenced by traffic volumes, traffic signal phasing parameters, and the vertical and horizontal alignments of the roadway. Therefore, the practitioner should consider these other factors when selecting the desired progression speed.

Figure 7-2: Basic Relationships among Traffic Signal Spacing, Progression Speed and Cycle Length



Source: Marks, H. *Traffic Circulation Planning for Communities*, p. 270.

Table 7-1 presents these same relationships – among progression speed, traffic signal spacing, and cycle length – in a tabular format. For a particular cycle length, the table shows the traffic signal spacing distances necessary to achieve various progression speeds. For example, at a cycle length of 80 seconds, spacing signals at 2,350 feet would result in a progression speed of 40 mph; however, reducing the spacing to 1,760 feet reduces the progression speed to 30 mph.

The signal spacing distances in *Table 7-1* range from a minimum of 1,100 feet (i.e., approximately 1/4 mile) at a 60-second cycle and a 25 mph progression speed, to a maximum of 2,640 feet (i.e., 1/2 mile). Note that 2,640 feet represents a practical maximum for the spacing of traffic signals at combinations of higher progression speeds and longer cycle lengths. On roadways where traffic signals are spaced more than ½ mile apart, variations in the travel speeds of individual vehicles begin to disperse the platoons, resulting in a loss of progression efficiency along the corridor.

The spacing distances shown in *Table 7-1* are intended to be used for spacing new traffic signals in areas where the desired signal control strategy is to optimize vehicle progression and where few traffic signals exist. Therefore, the traffic signal spacing distances shown in *Table 7-1* should be used in:

- Undeveloped areas, or
- Developing areas (e.g., areas that are part of a Port Authority redevelopment program), or
- Locations where existing signal spacing distances are one mile or more.

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Table 7-1: Speed and Cycle Length Table

Cycle Length (seconds)	Progression Speed (mph)						
	25	30	35	40	45	50	55
	Signal Spacing (feet)[b]						
60	1,100	1,320	1,540	1,760	1,980	2,200	2,420
70	1,280	1,540	1,800	2,050	2,310	2,570	2,640
80	1,470	1,760	2,050	2,350	2,640	2,640	2,640
90	1,630	1,980	2,310	2,640	2,640	2,640	2,640
120[a]	2,200	2,640	2,640	2,640	2,640	2,640	2,640

a. Longest recommended cycle length.

b. A signalized intersection within 300 feet of the ideal location is generally acceptable. Where minimum traffic signal spacing distances are impractical, minimum bandwidth guidelines apply (see Table 7-2).

Source: *New Jersey State Highway Access Management Code*, Appendix "D", New Jersey Department of Transportation.

7.3.1.2 Guidelines for Developed Areas

As noted previously, many Port Authority projects are located in *developed areas*, which are urbanized and characterized by one or more of the following features: a) dense roadside development, b) substantial number of existing intersecting roadways, c) limited right-of-way available for roadway improvements, d) existing environmental and/or topographic constraints, and/or e) significant pedestrian or transit considerations. Under these conditions, signal spacing along a corridor is often already limited by irregular street patterns, natural or topographical constraints, or existing tenant leasehold boundaries. In these cases, different guidelines from those for undeveloped areas apply. Vehicle progression can still be maintained by ensuring that a specific percentage of the cycle length is devoted to progressing through traffic along the corridor. In other words, the objective is to guarantee that major street through traffic is allocated no less than a specified minimum length of green time along the length of the corridor. (It should be noted that this results in a comparable decrease in the green time allocation to intersecting side streets). This objective is achieved by applying *minimum bandwidth guidelines* to major street through traffic at all signals located in the corridor's signal system. Applying the minimum bandwidth guidelines requires constructing a time-space diagram[18] for the subject corridor and determining the bandwidth for a specific timing plan. This section introduces and illustrates the components of a time-space diagram before presenting the minimum bandwidth guidelines for Port Authority roadways.

Bandwidth is the time available (expressed in seconds or as a percentage of the cycle length) for vehicles to travel through a traffic signal system at a specific progression speed. As such, bandwidth is a quantitative measurement of the through traffic capacity of a signal progression system: the greater the bandwidth, the higher the capacity for progressing through traffic along the corridor. The *through band* (or *green band*) is the time-space path whereby a motorist would encounter a green light indication at all signals in the system.

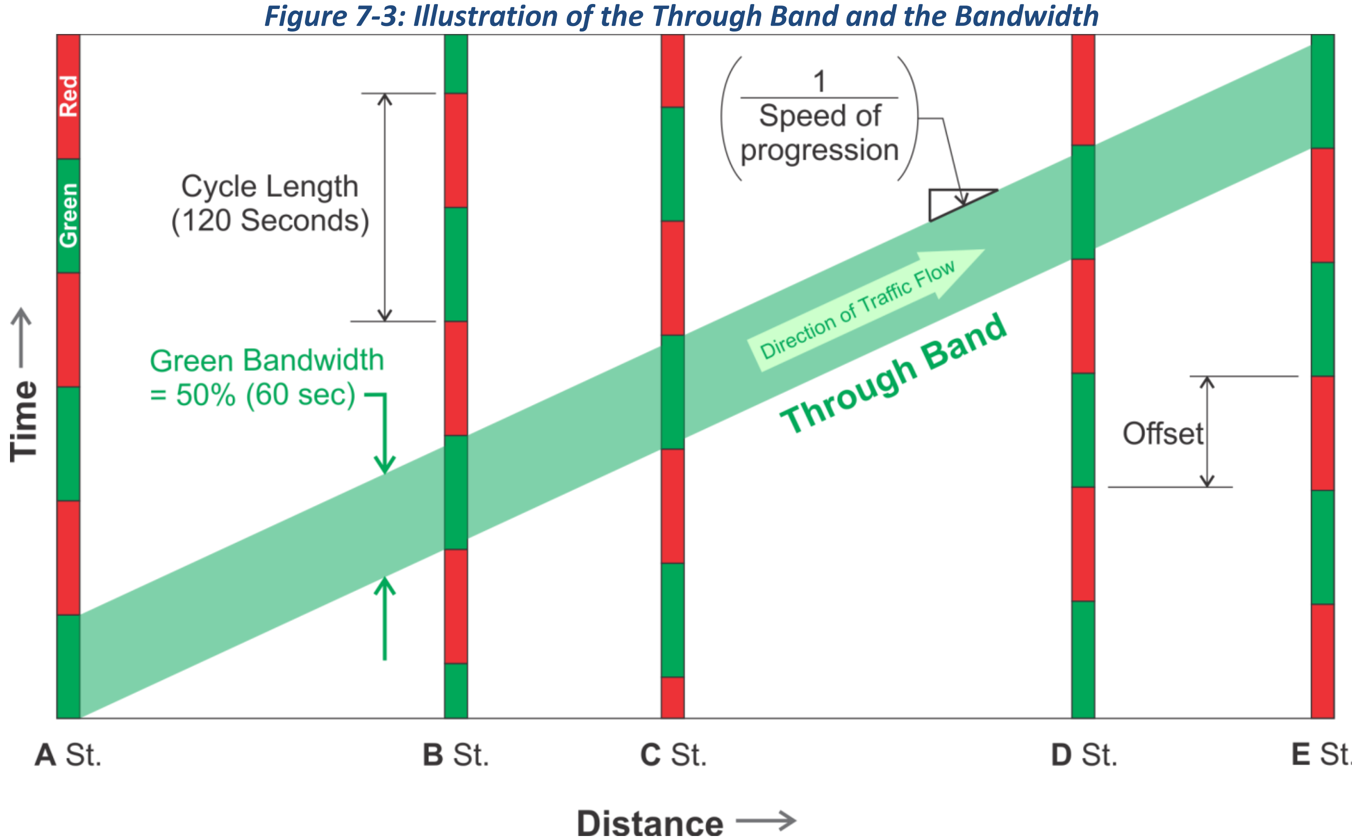
Figure 7-3 presents a time-space diagram showing an illustration of the through band and the bandwidth for traffic traveling in one direction along a corridor with five traffic signal-controlled intersections (i.e., "A Street"

[18] A *time-space diagram* is a graph on which the distance between signals and signal timing is plotted against time, and indicating the bandwidth and speed of traffic.

through "E Street") that are spaced at irregular distances along the length of the corridor. (*Figure 7-4* presents the same time-space diagram, but with "distance" on the vertical axis and "time" on the horizontal access, for readers more accustomed to this orientation.[19])

As shown in *Figures 7-3* and *7-4*, the alternating red-green timing at the intersections – coupled with the traffic signal offsets between adjacent intersections – allows for a continuous through band for the progression of major-street traffic through all five intersections in the signal system. This through band allows vehicles to travel, without stopping, through all five intersections at the progression speed. The duration of the bandwidth is the time elapsed between the passing of the first vehicle and the last possible vehicle moving without impedance through the traffic signal system at the progression speed. The vertical dimension of the through band in *Figure 7-3* (and the horizontal dimension of the through band in *Figure 7-4*) represents the bandwidth, which is shown to be 60 seconds, or 50 percent of the cycle length for the corridor. In practice, the bandwidth for a series of traffic signals along a corridor can be calculated either by preparing a time-space diagram manually or using a software program (e.g., SYNCHRO).

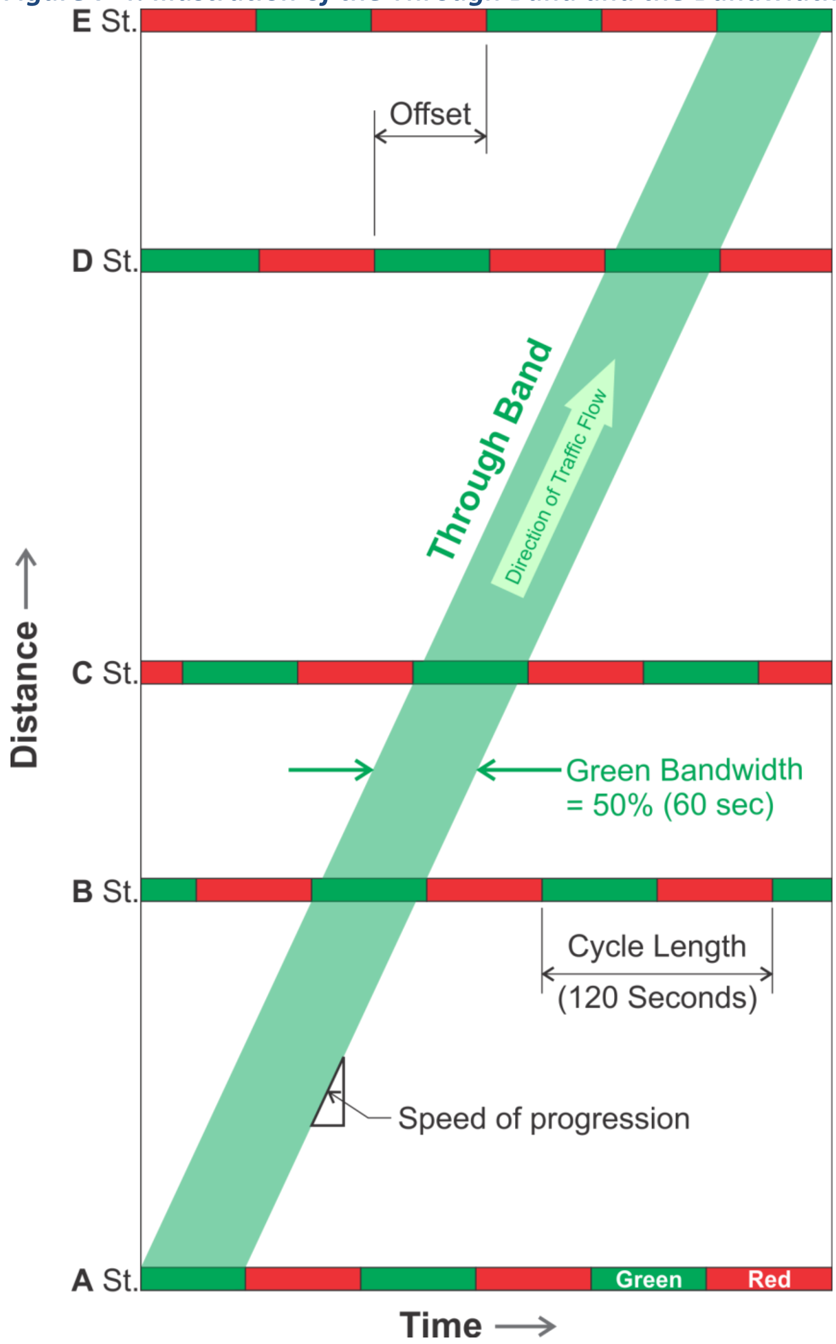
Figure 7-3: Illustration of the Through Band and the Bandwidth



Note: Figure 7-3 presents a time-space diagram with "distance" on the horizontal axis and "time" on the vertical axis. In contrast, Figure 7-4 presents "time" on the horizontal axis and "distance" on the vertical axis.
Source: Adapted from Banks, J.H., *Introduction to Transportation Engineering, 2nd Edition*, 2002, p. 308.

[19] Some readers may be accustomed to seeing a time-space diagram with "distance" on the horizontal axis and "time" on the vertical axis, as shown in Figure 7-3. Other readers may be accustomed to seeing "time" on the horizontal axis and "distance" on the vertical axis, as shown in Figure 7-4. Both versions are presented here.

Figure 7-4: Illustration of the Through Band and the Bandwidth



Note: Figure 7-4 presents a time-space diagram with "time" on the horizontal axis and "distance" on the vertical axis. In contrast, Figure 7-3 presents "time" on the vertical axis and "distance" on the horizontal axis.
Source: Adapted from Banks, J.H., *Introduction to Transportation Engineering, 2nd Edition*, 2002, p. 308.

Because of the higher traffic volumes typically found on principal arterials and arterials, wider bandwidths are desirable on these higher classification roadways. On the other hand, narrower bandwidths are acceptable on roadways of lower classification, such as collectors, because of the lower volumes, shorter trips served, and reduced driver expectations. Along local roads and other lower classification roadways, bandwidth is not a major consideration because the progression of through traffic is usually subordinate to the property access function of these roadways.

For developed areas where optimizing vehicle progression is the desired signal control strategy, the Port Authority's signal spacing guidelines are based on ensuring a minimum bandwidth is maintained along the corridor (requiring preparation of a time-space diagram as described above). The *Table 7-2* presents the minimum bandwidth guidelines for Port Authority facilities.

Table 7-2: Minimum Bandwidth Guidelines

Roadway Classification	Minimum Bandwidth[1]	
	Peak Periods	Off-Peak Periods[2]
Principal Arterial	45%	40%
Arterial	40%	35%
Collector	35%	30%
Local/Private Road	Progression not a criterion	

1. Where signalization already exists, and the bandwidth is less than the values shown in the table, an additional traffic signal may be permitted if it would not result in a reduction in the existing bandwidth.
2. Minimum bandwidth for off-peak periods applies where the peak hour of site-generated traffic would not coincide with the peak hour of traffic on the roadway network.

When optimizing vehicle progression is the desired signal control strategy, the minimum bandwidth guidelines shown in *Table 7-2* should be applied at all Port Authority facilities where:

- The project is located in a developed area, or
- The spacing of existing traffic signals is less than one mile.

Under these conditions, it is acceptable to install a new traffic signal provided that warrants are met and, with the new traffic signal in place, the traffic signal system along the corridor can meet the guidelines for minimum bandwidth shown in *Table 7-2*. If these minimum bandwidth criteria cannot be met, other traffic control devices should be considered, and other access strategies may be needed to serve the property (see *Chapter 13*). If none of these options provides a feasible solution, a design exception is needed (see *Chapter 14*).

7.3.2 Guidelines for Signal Control Strategy #2: Managing Queue Lengths to Prevent Spillback

On some roadways, existing signalized intersections may already be located in close proximity to one another. Due to the close spacing, vehicle queues may spill back from one intersection to the next, particularly during peak periods when volumes are high. Queue spillback from one signalized intersection into another can disrupt traffic operations at the upstream intersection as vehicles at the back of the queue block the turning paths of other vehicles, resulting in increased delays and reduced capacity. In addition, the congested conditions affect the safety performance of the roadway by increasing the potential for crashes. In some locations, gridlock can result.

Queue spillback may occur from different causes. In some cases, the close spacing of traffic signals may result from inconsistent planning practices. In other cases, traffic volumes have increased so much over time that what was once an acceptable condition has now become a problem. In either case, relocating one or both signals to meet any of the spacing guidelines described previously in this chapter (*Table 7-1* or *Table 7-2*) may be infeasible or cost-prohibitive.

Under these conditions, the Port Authority's desired signal control strategy may be to manage the lengths of the

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vehicle queues to prevent (or reduce the propensity for) spillback of queues from one intersection into the next. Queue spillback at existing closely-spaced intersections may be reduced or eliminated using a variety of operations, design, and traffic management strategies, including:

Less Costly / Easier to Implement Strategies:

- Modifying the timing and/or phasing parameters at one or both traffic signals, including:
  - Adjustments to phase lengths (timing)
  - Adjustments to phasing sequences
  - Adjustments to the offsets between the signals
- Metering the approaching (upstream) demand
- Prohibiting certain turning movements by time-of-day (or at all times)
- Signing and striping (e.g., "Don't Block The Box" or "Do Not Block Intersection" signs, cross-hatched striping inside the physical junction of the intersecting roadways, see *Photo 7-1*)

More Costly / More Difficult to Implement Strategies:

- Adding capacity to one or both intersections using any of the following design techniques:
  - Restriping approaches to the intersections to provide a lane configuration that is more suitable for prevailing traffic conditions
  - Widening one or more of the intersecting roadways to provide additional lanes
  - Channelizing right-turn movements (i.e., moving them outside of the intersection where they do not need to operate under signal control)
- Implementing alternative left-turn treatments

In locations where the Port Authority's prevailing signal control strategy is to manage queue lengths to prevent spillback, the strategies listed above – and combinations thereof – should be examined and tested as part of a comprehensive study, recognizing that each project is different and should be assessed individually. In all cases, however, the 95th percentile queue length[20], commonly-used for design purposes, should be applied where the desired signal control strategy is to manage queue lengths to prevent spillback.

It should be noted that most traffic engineering software packages (e.g., HCS, SYNCHRO) calculate queue lengths as one of their output parameters and should be used for testing many of the strategies identified above. Carefully calibrated simulation models may be applied to determine the impacts that various strategies have on the resulting queue lengths.

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[20] The 95th-percentile queue length represents the distance that would not be exceeded by a queue of vehicles 95 percent of the time during the analysis period.

Photo 7-1: "Do Not Block Intersection" Sign and Cross-Hatched Striping at Intersection

Photo source: Port Authority archives (looking west on 14th Street from Manila Avenue on the New Jersey exit from the Holland Tunnel).

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7.3.3 Guidelines for Signal Control Strategy #3: Optimizing Pedestrian Flow

In some locations, traffic signals are installed primarily to provide efficient pedestrian crossings, optimizing pedestrian flow across a roadway, rather than to accommodate vehicular traffic movements. One example of this is a series of pedestrian crosswalks that span the inner and outer lanes of an airport terminal frontage road to connect the airport terminal to a nearby parking facility.

Where the Port Authority's prevailing signal control strategy is to optimize pedestrian flow, a tenant may be asked to perform a comprehensive engineering study. The engineering study shall be conducted by a professional traffic engineer and should examine the relationships among the spacing, location, design features, and operation of existing and proposed traffic signals. The engineering study should include analysis and/or simulation of conditions involving both pedestrian crossings and intersecting motor vehicle traffic. At the team conceptual planning meeting with Port Authority Traffic Engineering, a detailed scope of work for the study will be developed and may include an examination of the following parameters:

- Crosswalk locations and relevant traffic control devices
- Pedestrian crossing volumes by time-of-day (i.e., peak and off-peak volumes)
- Pedestrian walking speeds and platooning characteristics
- Types of pedestrians crossing the roads (e.g., visitors versus employees, families with children, patrons with luggage)
- Delay for pedestrian crossings by time-of-day
- Motor vehicle volumes by time-of-day
- Delays for motor vehicle traffic
- Approach speeds for motor vehicle traffic
- Sight lines and available sight distances between pedestrians and drivers
- Expectations of drivers and motorists
- Illumination levels and visual clutter

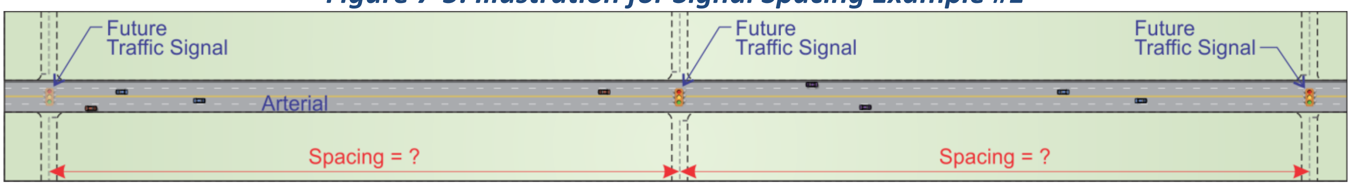
7.4 Example Calculations

7.4.1 Example #1: Signal Spacing in a Developing Area – Strategy: Optimize Vehicle Progression

Given:

- An arterial roadway is located in a developing area with no existing traffic signals and no intersecting cross-streets.
- A Port Authority redevelopment program is being undertaken that is projected to result in new development along the arterial with the potential to require several future traffic signal installations (provided warrants in the *Manual on Uniform Traffic Control Devices* are met). See *Figure 7-5*.
- The desired signal control strategy along the roadway is the optimization of vehicle progression.
- The desired progression speed is 35 mph, and the cycle length for new traffic signals along the roadway is 90 seconds.

Figure 7-5: Illustration for Signal Spacing Example #1



Problem: Find the spacing for new traffic signal installations along the arterial roadway.

Solution:

- Refer to *Figure 7-1* for guidance on determining the traffic signal spacing guidelines to be applied. Because the project is a Port Authority redevelopment program and the signal control strategy is to optimize vehicle progression, either the speed and cycle length table (*Table 7-1*) or minimum bandwidth guidelines could be used. However, because there are no existing traffic signals along the roadway (to potentially constrain the green bandwidth), the speed and cycle length table should be used in this case.
- Referring to *Table 7-1*, the signal spacing corresponding to a progression speed of 35 mph and a cycle length of 90 seconds is 2,310 feet. Because no intersecting cross-streets currently exist along the arterial roadway, there are no pre-established locations for potential future traffic signal installations. Therefore, to achieve the desired signal control strategy of optimizing vehicular progression, all new traffic signal installations along the arterial should be spaced approximately 2,310 feet apart.
- In addition, given that the area is newly developing, it is also desirable to proactively establish a supporting street network as well as potential future signal locations, to reduce reliance on the arterial roadway as the sole means for property access (see *Chapter 13*).

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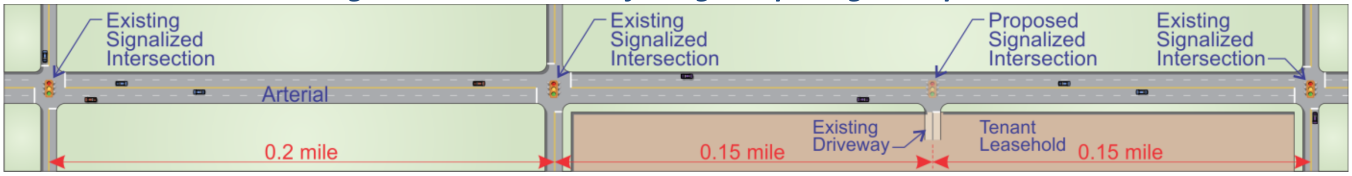
7.4.2 Example #2: Signal Spacing in a Developed Area – Strategy: Optimize Vehicle Progression

Given:

- To accommodate a change in business operations, a Port Authority tenant desires a new traffic signal at an existing driveway serving its leasehold, as shown in *Figure 7-6*.
- The driveway where the signal is desired is located along a Port Authority roadway that is classified as an arterial and has several existing traffic signals spaced as shown in *Figure 7-6*. The desired progression speed along the arterial is 30 mph.
- Discussion with Port Authority Engineering at the team conceptual planning meeting indicates that the applicable signal control strategy is to maintain vehicular progression along the arterial and not reduce the green bandwidth during peak periods.
- The existing cycle length for all existing traffic signals located along the arterial is 60 seconds.
- Existing green bandwidths are:
  - 36 percent during peak periods (below the minimum bandwidth threshold of 40 percent for arterials noted in *Table 7-2*)
  - 45 percent during off-peak periods (exceeding the minimum bandwidth threshold of 35 percent for arterials noted in *Table 7-2*)
- An engineering study, prepared following the *Port Authority Intersection Signalization Procedures*[21], indicates that a new traffic signal would meet *MUTCD* traffic signal warrants under projected future traffic conditions.

Figure 7-6: Illustration for Signal Spacing Example #2



Problem: Determine if the tenant's driveway along the arterial can be signalized as desired, given the parameters above.

Solution:

- Refer to *Figure 7-1* for guidance on determining the traffic signal spacing guidelines to be applied. The project is not part of a redevelopment program and the engineering study suggests that the signal should be progressed for consideration based on meeting MUTCD warrants.
- Because there are existing signals located within one mile of the desired location and Port Authority Engineering indicates that the applicable signal control strategy is to maintain vehicular progression along

[21] Step 2 of Process B: "Procedures for Installation of a New Traffic Signal Requested by Private Entities."

the arterial and not reduce the green bandwidth during peak periods, the minimum bandwidth guidelines shown in *Table 7-2* apply.

- A corridor-level traffic signal progression analysis, involving preparation of a time-space diagram (not shown here), is then needed to determine the bandwidth that can be achieved along the arterial with the new traffic signal in place. As noted above, the existing green bandwidths are:
  - 36 percent during peak periods (currently *below* the minimum bandwidth threshold of 40 percent) and
  - 45 percent during off-peak periods (currently *exceeding* the minimum bandwidth threshold of 35 percent)
- The progression analysis indicates that – with the proposed traffic signal in place – the projected bandwidth during off-peak periods would be reduced from 45 percent to 42 percent under future conditions. The projected 42 percent bandwidth under future conditions is still above the minimum bandwidth threshold of 35 percent specified in *Table 7-2*.
- However, the progression analysis also indicates that – with the proposed traffic signal in place – the projected bandwidth during peak periods would be reduced from 36 percent to 33 percent under future conditions. The projected 33 percent bandwidth under future conditions is not only below the minimum threshold specified in *Table 7-2*, but also below the existing 36 percent bandwidth.
- Therefore, if operational, design, or traffic management measures cannot maintain the existing bandwidth during peak periods, then the driveway should not be signalized and other access management strategies should be pursued to accommodate tenant's needs (see *Chapter 13*) or a design exception is needed for the proposed traffic signal location (see *Chapter 14*).

7.4.3 Example #3: Signal Spacing in a Developed Area – Strategy: Manage Queue Lengths

Given:

- An arterial roadway has two existing signalized intersections spaced as shown in *Figure 7-7*.
- To accommodate a change in business operations, a Port Authority tenant abutting the arterial between the two existing traffic signals desires a new traffic signal at an existing driveway serving its property.
- Discussions with Port Authority Engineering at the team conceptual planning meeting indicate that the applicable signal control strategy along the arterial is to manage queue lengths to prevent vehicle spillback between intersections.

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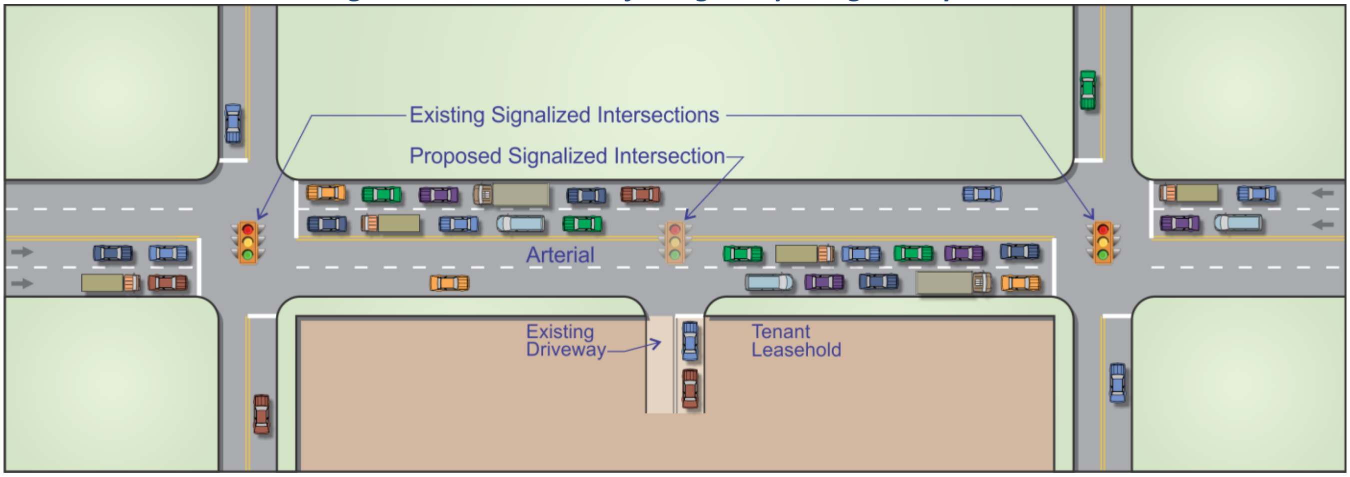
Figure 7-7: Illustration for Signal Spacing Example #3



Problem: Determine if the tenant's driveway along the arterial can be signalized as desired, given the parameters above.

Solution: The steps for determining the solution to this problem are outlined below (a numerical solution is not provided):

- Because Port Authority's signal control strategy is to manage queue lengths, the primary objective is to prevent spillback of vehicle queues between the intersections. Traffic operations analysis of the two existing signalized intersections – as well as the signalized intersection proposed by the tenant – under projected future traffic conditions is needed to determine the 95th percentile queue lengths between all three intersections.

- The 95th percentile queuing results of the future conditions traffic operations analysis should be examined. If the projected future 95th percentile vehicle queues from adjacent intersections along the arterial do not spillback into each other, the tenant's proposed traffic signal may be allowed, provided a warrant analysis determines that a signal is warranted at this location.

- If the future conditions traffic analysis reveals that 95th percentile queues along the arterial extend back into adjacent intersections, the strategies presented in *Section 7.3.2* should be tested to identify what improvement measures — or combinations of measures — may result in vehicle queues along the arterial that do not spillback into adjacent intersections. If no solutions are identified, the signal should not be allowed. However, the tenant may request a design exception for the proposed traffic signal location, subject to approval from the Port Authority.

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CHAPTER 8: ACCESS IN THE VICINITY OF INTERCHANGES

8.1 Overview

Freeway interchanges, important focal points of activity, provide the means of moving traffic between freeways and intersecting cross roads. Although direct property access is prohibited on the freeway itself, operational problems can arise when driveways and intersections along the cross road are spaced too close to the interchange ramp termini, resulting in heavy weaving volumes, complex traffic signal operations, frequent crashes, and recurrent congestion. In addition, driveways and median breaks that are provided for direct access to properties along the cross road compound these problems.

Managing access on cross roads in the vicinity of interchanges protects the longevity of both the interchange and the intersecting cross road by minimizing congestion, reducing crash rates, and simplifying driving tasks. Improperly managing access on the cross road near the interchange may cause congestion and potential crashes, thereby shortening the life cycle of the interchange. In addition, it may cause significant impairment of cross road and freeway mainline safety and operations. For these reasons, access management should be applied to interchange cross roads such that access points – including both driveways and intersections – are sufficiently separated from freeway interchange ramp terminals[22].

8.2 Guidelines

The guidelines for the spacing of access points in the vicinity of interchanges vary depending on the existing (or anticipated future) traffic control devices at the intersection between the freeway ramp terminal and the cross road. Separate guidelines exist for locations where the ramp operates:

A) under either STOP sign or traffic signal control, or

B) as a free-flow merge or under yield-control

The guidelines associated with each of these traffic control conditions are described below.

8.2.1 Spacing Guidelines for Stop-Controlled or Signal-Controlled Ramp Terminals

Where the intersection between a freeway ramp terminal and a cross road operates under STOP sign or traffic signal control (see *Figure 8-1*), the dynamics of traffic movements from the freeway to the cross road – and along the cross road – are similar to other roadways that involve STOP-controlled and traffic signal controlled driveways and intersections. Under these circumstances, the spacing guidelines to be applied on the cross road shall be in accordance with the applicable guidance presented previously in *Chapter 5* (Unsignalized Driveway Spacing), *Chapter 6* (Intersection Corner Clearance) and *Chapter 7* (Traffic Signal Spacing).

[22] A "ramp terminal" is the intersection of a freeway ramp (entrance or exit ramp) and a surface street.

Figure 8-1: Stop or Signal Control at Interchange Ramp

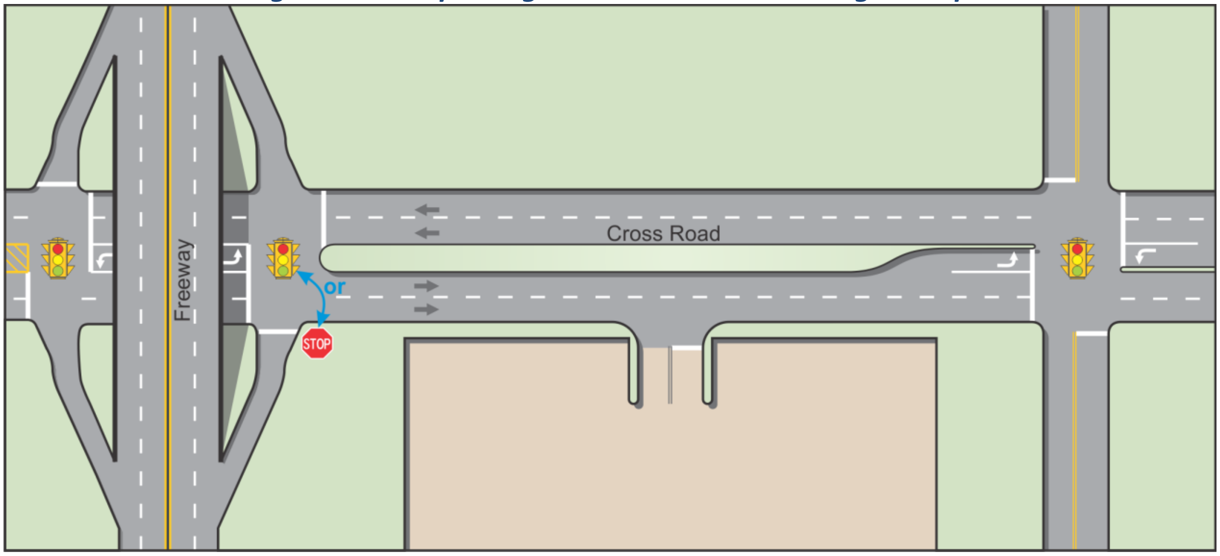
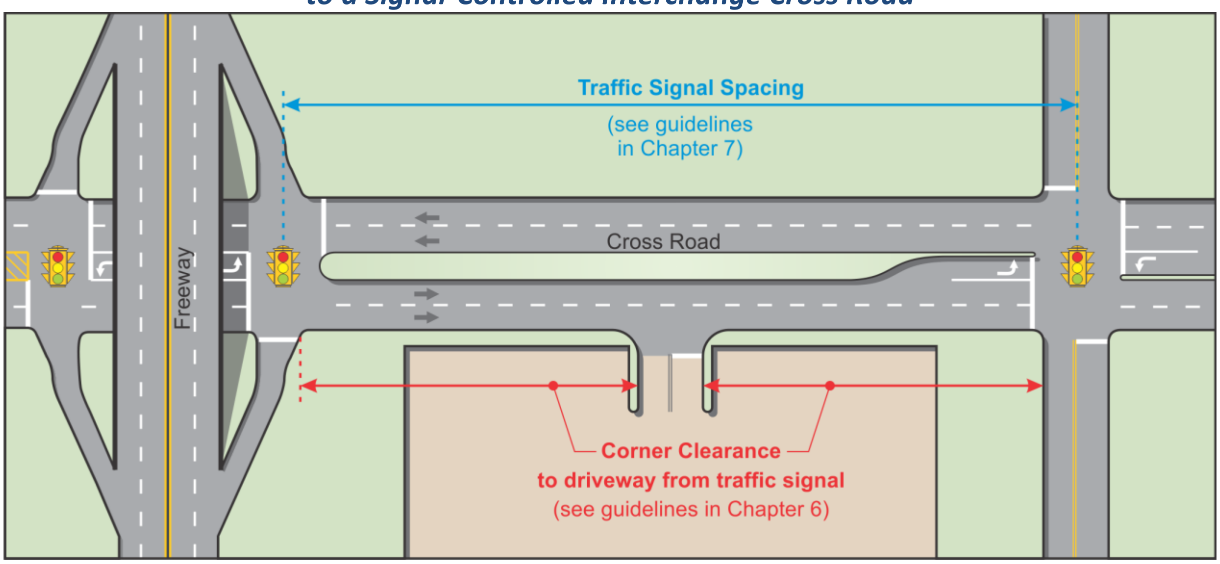


Figure 8-2 illustrates how the guidelines from *Chapters 6* and *Chapter 7* would be applied to determine:

1) The corner clearance between a signalized interchange ramp terminal and a STOP-controlled driveway on the cross road (*Chapter 6*)

2) The spacing between a signalized interchange ramp terminal and a signalized intersection on the cross road (*Chapter 7*)

Figure 8-2: Application of Traffic Signal Spacing and Corner Clearance Guidelines to a Signal-Controlled Interchange Cross Road



At intersections where the ramp terminal is STOP-controlled at the cross road, consideration should be given to the possibility that this intersection may become signalized in the future as a result of traffic volumes increasing over time. Under these circumstances, where traffic signal control at the ramp terminal is anticipated in the future, the traffic signal spacing guidelines and corner clearance guidelines should be applied rather than the unsignalized driveway spacing guidelines; application of the unsignalized spacing guidelines might not provide sufficient spacing of driveways and intersections along the cross road under future conditions.

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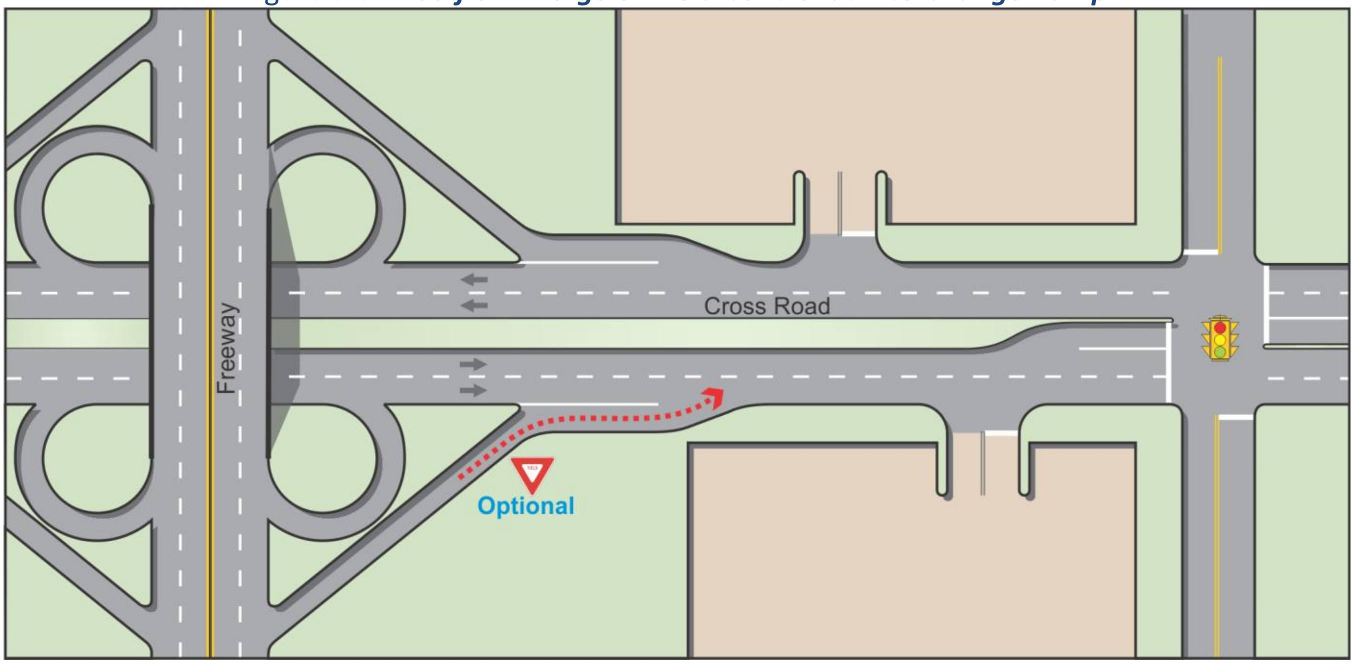
8.2.2 Spacing Guidelines for Free-Flow Merge or Yield-Controlled Ramp Terminals

In locations where the ramp terminal connects to the intersecting cross road via a free-flow merge (see *Figure 8-3*), drivers exiting the freeway via the ramp do not need to stop, but rather merge with traffic traveling on the cross road. Similar traffic flow dynamics exist in locations where the ramp terminal is yield-controlled at the cross road.

Figure 8-3***: Free-flow Merge or Yield Control at Interchange Ramp***



Under free-flow conditions, sufficient access spacing should be provided along the cross road to allow drivers to first merge with the cross road traffic, maneuver into the proper lane, and decelerate to the back of any queue before turning at a driveway or intersection. The following sections provide guidelines for these access configurations:

- **Spacing between an exit ramp terminal and the first full-movement street intersection or driveway** (i.e., where left-turns are allowed): see *Figure 8-4*.
- **Spacing between an exit ramp terminal and the first downstream right-in/right-out street intersection or driveway** (i.e., where left-turns are prohibited by a non-traversable median): see *Figure 8-5*.
- **Spacing between right-in/right-out street intersection or driveway and a downstream entrance ramp** (i.e., where left-turns are prohibited by a non-traversable median): see *Figure 8-6*.

Figure 8-4: Illustration of Driver Maneuvers required for a Downstream Full-Access Street Intersection

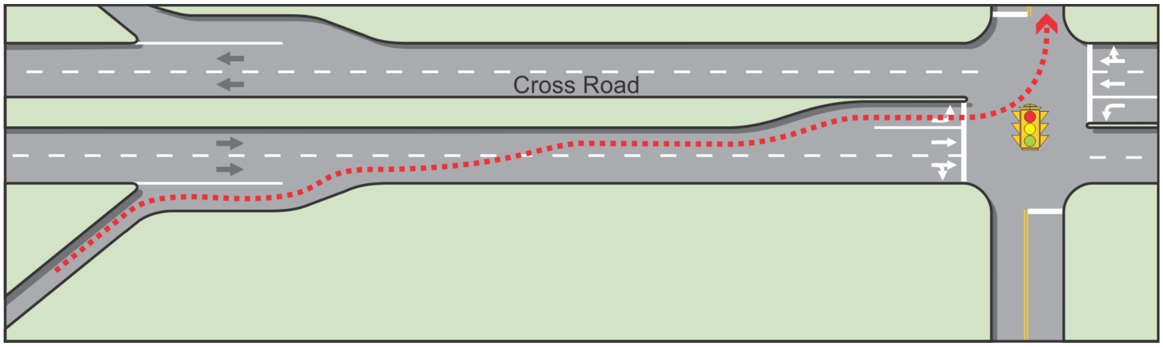


Figure 8-5: Illustration of Driver Maneuvers required for a Downstream Right-In/Right-Out Street Intersection or Driveway

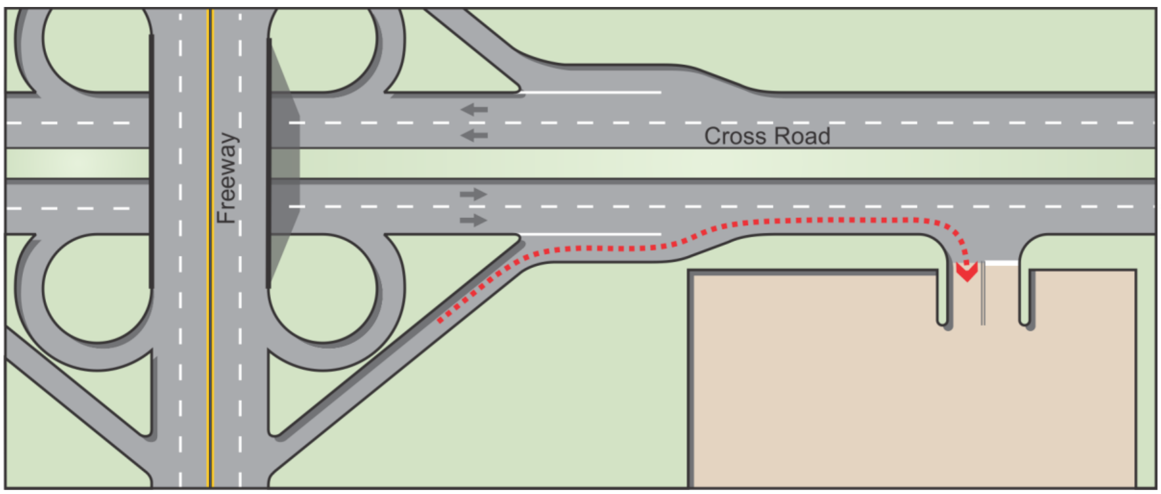
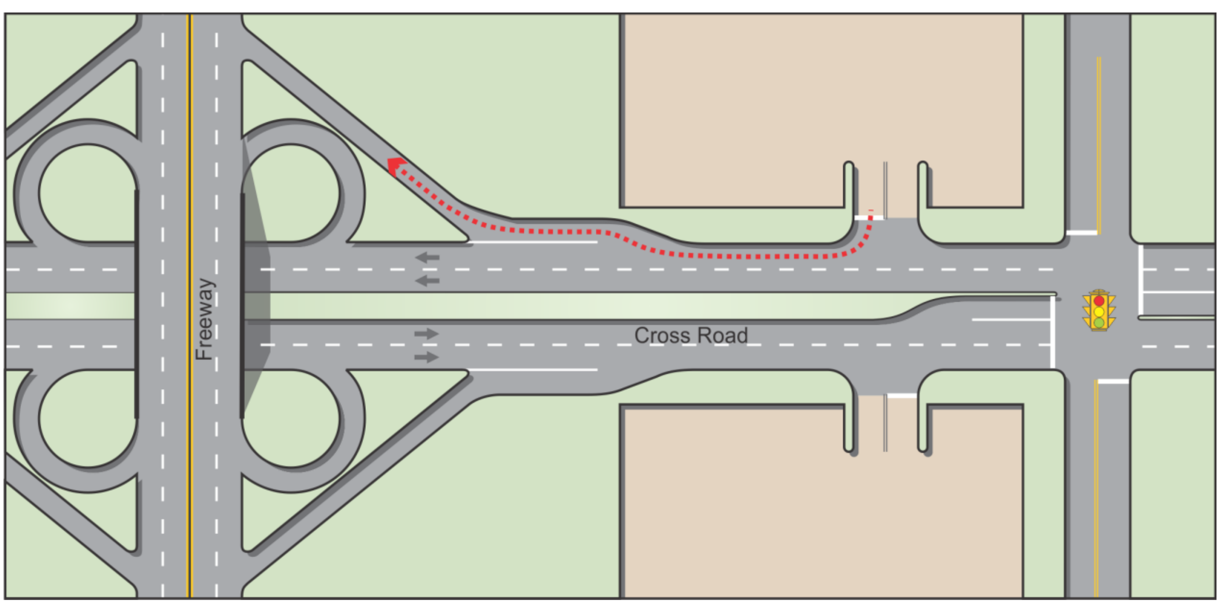


Figure 8-6: Illustration of Driver Maneuvers required for a Right-In/Right-Out Street Intersection or Driveway and a Downstream Entrance Ramp



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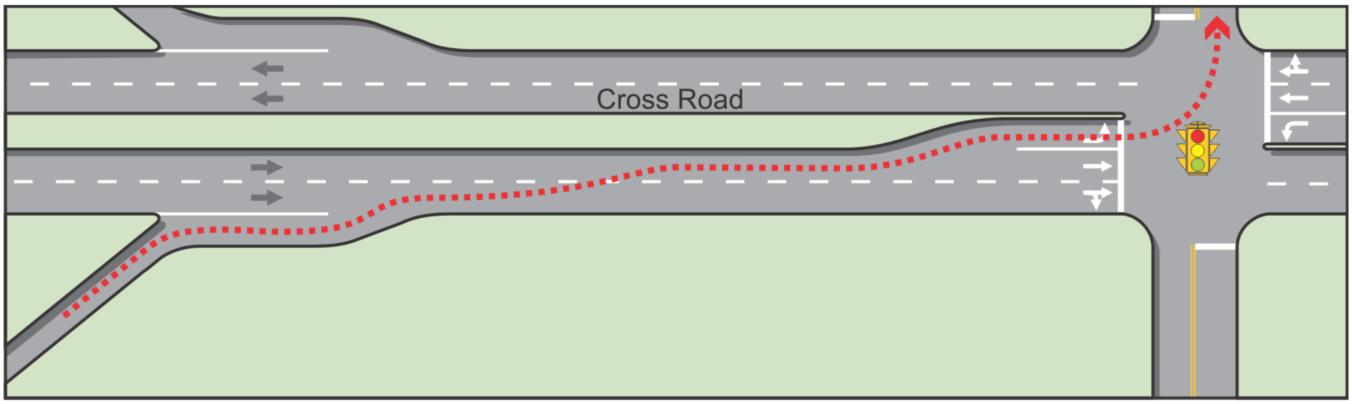
8.2.2.1 Spacing to First Full-Movement Street Intersection or Driveway

A full-movement street intersection or driveway is one where all turning movements, including left-turns, are allowed from all approaches. Relative to right-in/right-out street intersections and driveways, a full-movement street intersection or driveway requires greater spacing from the ramp terminal. This is because, as shown in *Figure 8-7*, in order for a driver exiting the freeway to make a downstream left-turn on the cross road, the driver must:

1) Merge from the freeway ramp into the vehicle stream on the cross road;
2) Weave across traffic on the cross road to enter the left lane;
3) Transition into the exclusive left-turn lane[23]; and
4) Decelerate to the back of the left-turning queue at the downstream, full-movement street intersection or driveway and complete the left-turn.

Figure 8-7: Illustration of Driver Maneuvers required for a Downstream Full-Access Street Intersection

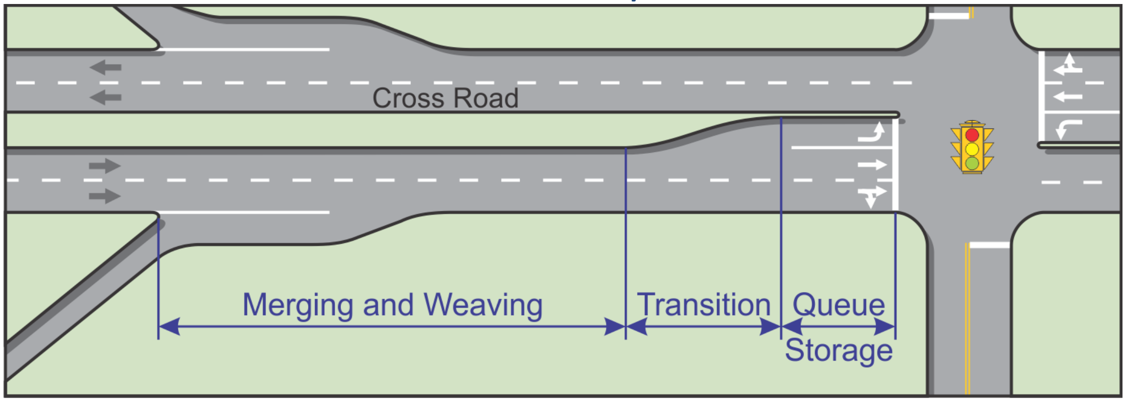


Of all possible turning movements at the downstream location, the merge, weave, and transition to the left-turn lane described above requires the greatest distance for the driver to complete. Therefore, full-movement street intersections and driveways require the greatest spacing from the ramp terminal. The following guidelines for desirable spacing distances should be applied to all full-movement street intersections and driveways in the vicinity of exit ramp terminals. These distances are illustrated in *Figure 8-8* and *Figure 8-9*, respectively. The desirable spacing distance equals the minimum spacing distance plus an additional decision distance.

[23] If an exclusive left-turn lane exists.

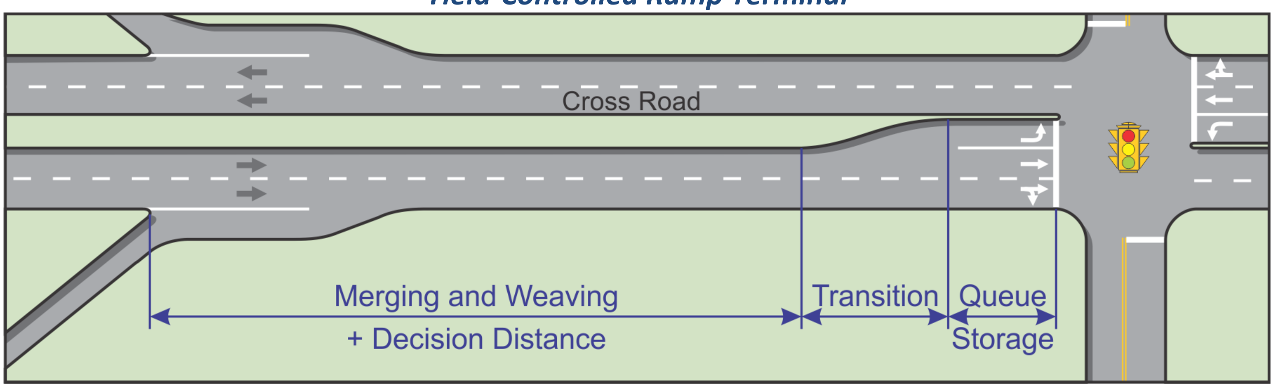
Minimum Spacing Distance to First Full-Movement Street Intersection or Driveway = (Merging and Weaving Distance) + Transition Distance + Queue Storage Distance

Figure 8-8: Components for Minimum Spacing Distance from a Free-Flow Merge or Yield-Controlled Ramp Terminal



Desirable Spacing Distance to First Full Movement Street Intersection or Driveway = (Merging and Weaving Distance) + Decision Distance + Transition Distance + Queue Storage Distance

Figure 8-9: Components for Desirable Spacing Distance from a Free-Flow Merge or Yield-Controlled Ramp Terminal



The major inputs for the two equations above are determined in specific ways. Below are the particulars of how to arrive at the merging and weaving distance, transition distance, queue storage distance, and decision distance:

Merging and Weaving Distance – The combined merging and weaving distance is measured from the gore point of the ramp (see *Figure 8-8* and *Figure 8-9*) and is a function of the number of lanes on the cross road in the subject direction of travel, as shown in *Table 8-1*.

Table 8-1: Merging and Weaving Distances

Number of Lanes on Cross Road in Direction of Travel	Merging and Weaving Distance
1 Lane	800 feet
2 Lanes	1,200 feet
3 Lanes	1,600 feet

Source: Gluck, J., H.S. Levinson and V. Stover, *NCHRP Report 420: Impacts of Access Management Techniques*, 1999, Table 86, p. 119.

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Transition Distance – The length of the transition distance is determined as follows, based on: a) whether there is an exclusive left-turn lane at the downstream street intersection or driveway, and b) whether there is a non-traversable median on the cross road:

- Where there is no exclusive left-turn lane at the downstream street intersection or driveway, no transition distance is needed (transition distance = 0).
- Where an exclusive left-turn lane exists at the downstream street intersection or driveway, and a non-traversable median exists along the cross road, the transition distance is determined using the median taper design guidance provided in AASHTO's *A Policy on Geometric Design of Highways and Streets* (i.e., the "Green Book").[24]
- Where an exclusive left-turn lane exists at the downstream street intersection or driveway, and no median exists on the cross road, the transition distance is 75 feet.

Queue Storage Distance – The queue storage distance is based on the 95th percentile queue length[25] on the approach to the downstream street intersection or driveway in the subject direction of travel during the year of full build-out. The queue storage distance is the greater of:

1) The 95th percentile queue length calculated for the left-turn movement at the downstream intersection, in the subject direction of travel, or

2) The 95th percentile queue length calculated for the through movement adjacent to the left-turn movement at the downstream intersection, in the subject direction of travel.

Decision Distance – Because the driving population at Port Authority facilities often includes significant numbers of visitors who may be unfamiliar with the facility, it is desirable to provide additional time and distance for sign reading and decision-making by those drivers. The decision distance is given in *Table 8-2*, based on the posted speed on the cross road in the subject direction of travel.

Table 8-2: Decision Distance

Posted Speed (mph)	Decision Distance (feet)
30	535
35	625
40	715
45	800
50	890

Source: Adapted from AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2011, Table 3-3, p. 3-7.

Where the decision distance given in *Table 8-2* is not achievable, a design exception is needed.

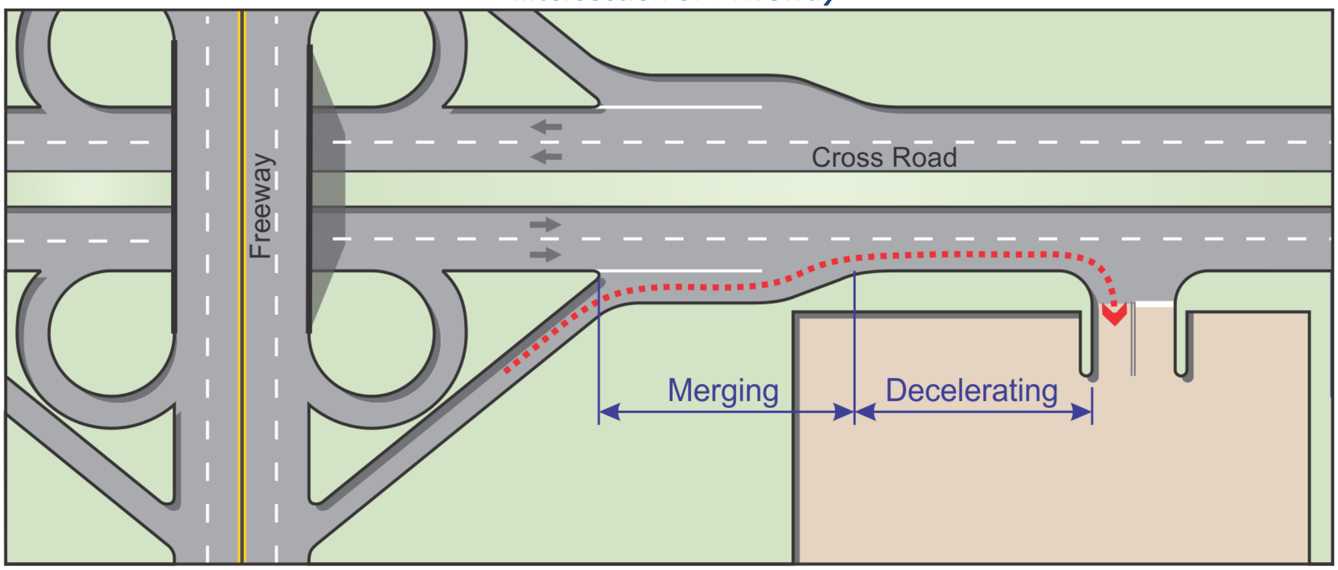
[24] See pages 9-127 to 9-130 of the 2011 edition, or superseding edition.

[25] The 95th percentile queue length represents the distance that would not be exceeded by a queue of vehicles 95 percent of the time during the analysis period. For major street approaches to two-way stop-controlled intersections where only the intersecting minor street is stop-controlled, the queue length = 0.

8.2.2.2 Spacing to First Downstream Right-In/Right-Out Street Intersection or Driveway

A right-in/right-out intersection is one where all left-turn movements are prohibited by a non-traversable median along the cross road. Relative to full-movement street intersections and driveways, right-in/right-out street intersections and driveways require less spacing from the ramp terminal. As shown in *Figure 8-10*, a driver exiting the freeway via the ramp and making a downstream right-turn from the cross road into a street intersection or driveway must: 1) merge from the freeway ramp into the right-lane of the cross road; and 2) decelerate to turn right into the downstream street intersection or driveway.

Figure 8-10: Illustration of Driver Maneuvers required for a Downstream Right-In/Right-Out Street Intersection or Driveway



The following guidelines for minimum and desirable spacing distances have been identified for downstream right-in/right-out street intersections and driveways in the vicinity of ramp terminals. These *Guidelines* reference the unsignalized driveway spacing guidelines presented in *Chapter 5*, based on the roadway access classification of the cross road and the posted speed in the direction of travel along the cross road. These distances are illustrated in *Figure 8-11* and *Figure 8-12*, respectively.

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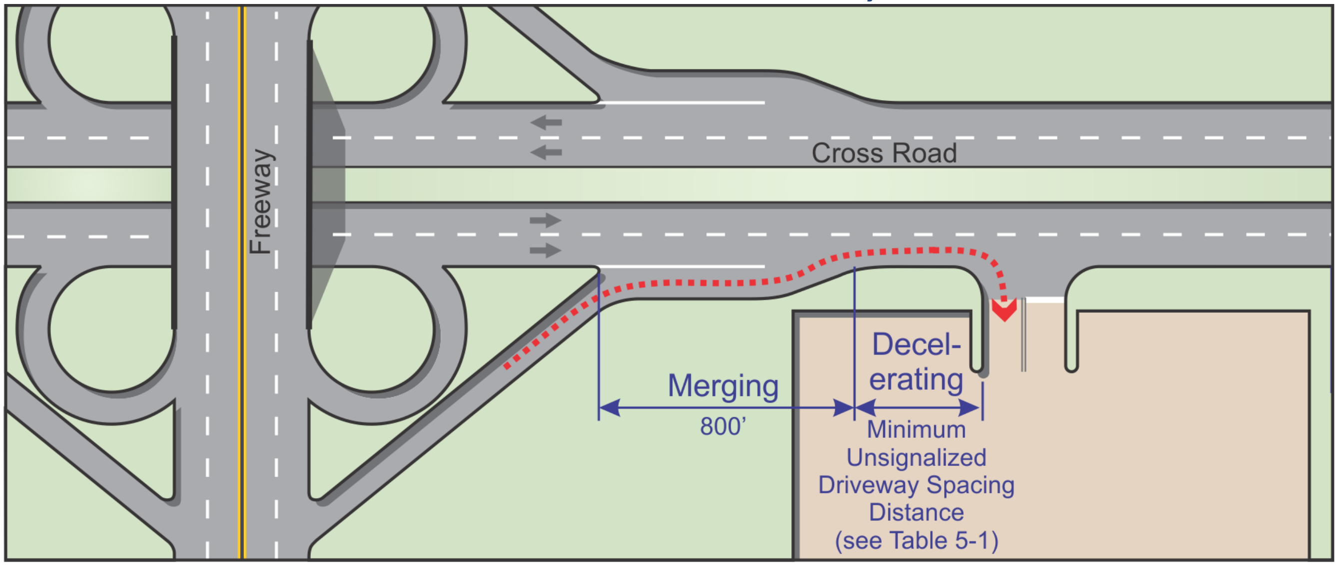
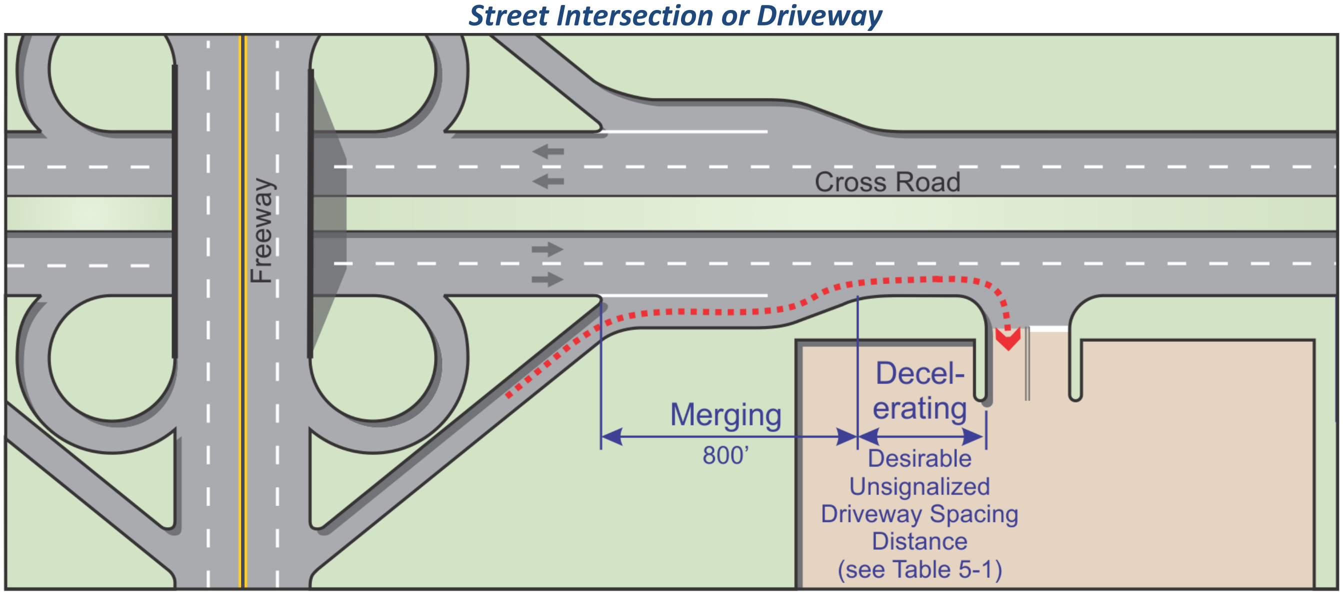
Minimum Spacing Distance to First Right-In/Right-Out Street Intersection or Driveway = 800 feet[26] + **MINIMUM** Unsignalized Driveway Spacing Distance

Figure 8-11: Components for Minimum Spacing Guidelines for a Downstream Right-In/Right-Out Street Intersection or Driveway



Desirable Spacing Distance to First Right-In/Right-Out Street Intersection or Driveway = 800 feet + **DESIRABLE** Unsignalized Driveway Spacing Distance

Figure 8-12: Components for Desirable Spacing Guidelines for a Downstream Right-In/Right-Out Street Intersection or Driveway

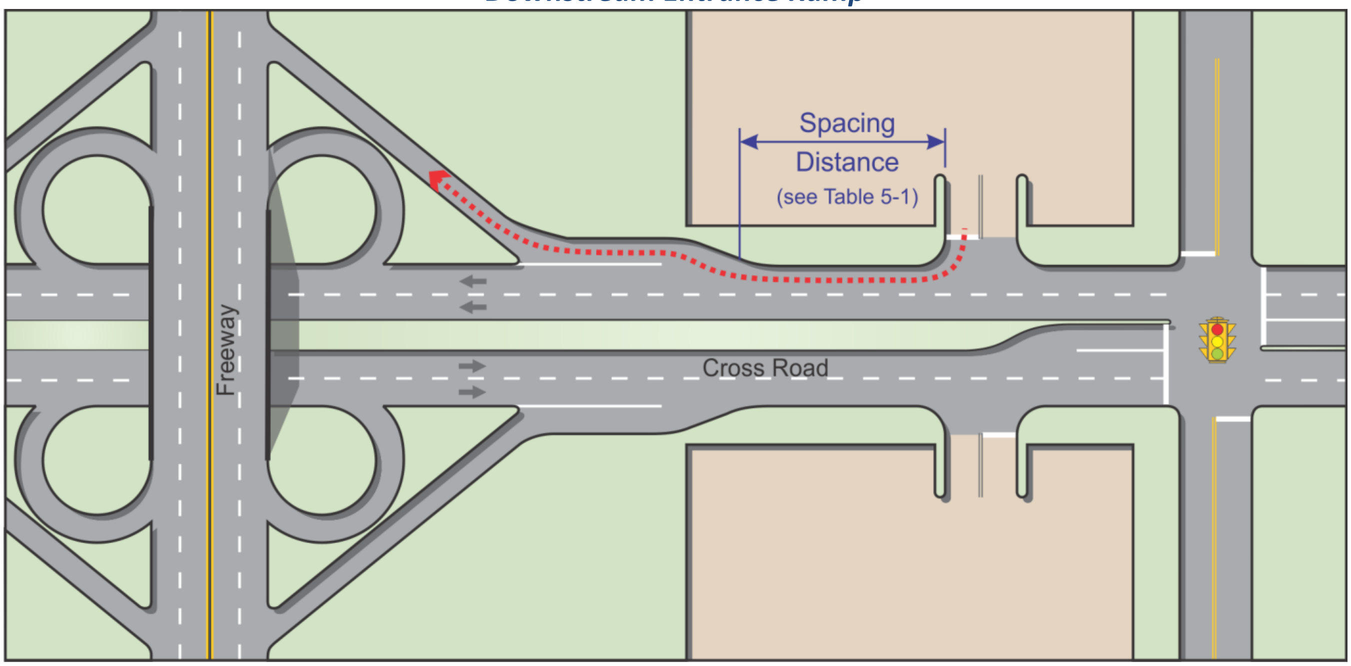


[26] The 800 foot distance begins at the gore point of the ramp, and is a constant. It does not vary based on speed, volume, or grade.

8.2.2.3 Spacing between Right-In/Right-Out Street Intersection or Driveway and Downstream Entrance Ramp

A right-in/right-out street intersection or driveway may also be located along the cross road *upstream* of a freeway entrance ramp (i.e., on-ramp), as shown in *Figure 8-13*. Under these conditions, the unsignalized driveway spacing guidelines presented in *Chapter 5* shall be applied to determine the distance between the right-in/right-out street intersection or driveway and the downstream entrance ramp. As shown in *Figure 8-13*, the spacing distance is measured from the edge of the street intersection or driveway to the start of the transition taper for the ramp.

Figure 8-13: Spacing Guideline for a Right-In/Right-Out Street Intersection or Driveway and a Downstream Entrance Ramp



8.3 Example Calculations

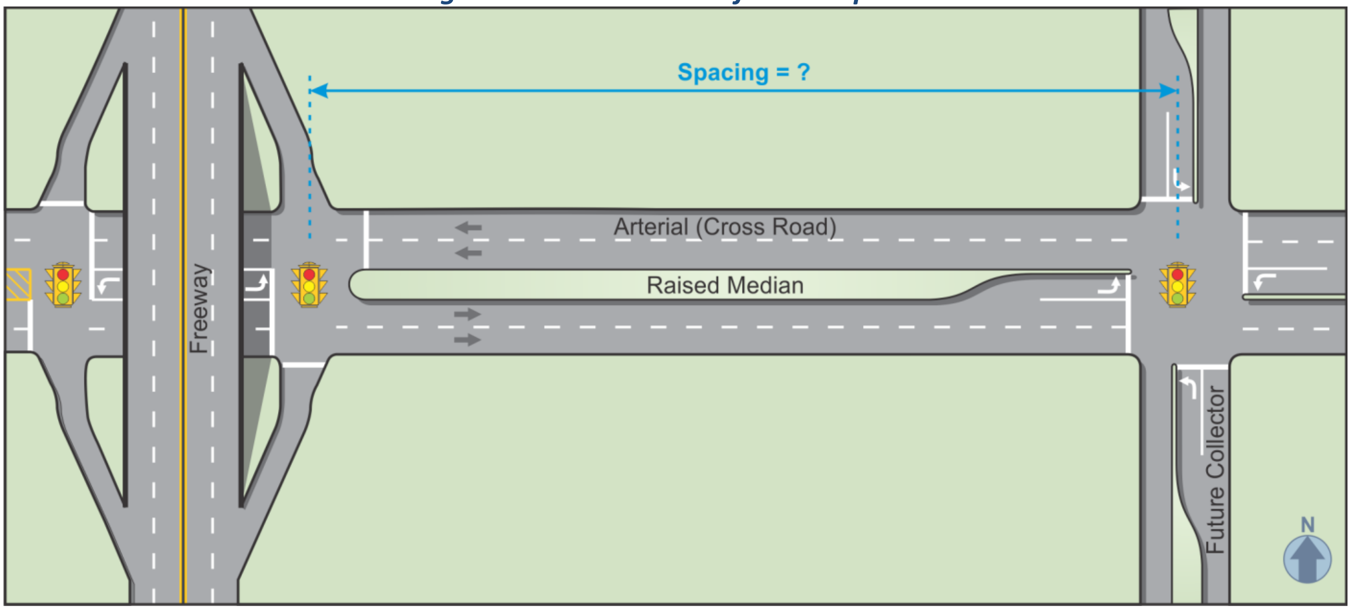
8.3.1 Example #1: Spacing from Signalized Ramp Terminal to First Full-Movement Street Intersection

Given:

- A freeway interchange with both ramp terminals signalized on the cross road (see *Figure 8-14*). The cross road is classified as an arterial with a posted speed of 35 mph.
- Left-turn ingress and egress between the arterial and abutting properties are currently prohibited by a non-traversable median along the arterial.
- The Port Authority is planning to build a new collector roadway that will intersect with the arterial some distance from the interchange, as shown in *Figure 8-14*. A break in the non-traversable median along the arterial would be needed to provide left-turn access. An engineering study conducted following the *Port Authority Intersection Signalization Procedures* has determined that a traffic signal would be warranted at the arterial/collector intersection. No other traffic signals are located within one mile of the interchange.
- The Port Authority's signal control strategy in this area is to optimize vehicle progression along the

arterial at a progression speed of 35 mph. The existing cycle length at the interchange signals is 60 seconds; the arterial/collector intersection would operate on the same cycle length.

Figure 8-14: Illustration for Example #1



Problem: Determine the desirable spacing along the arterial between the interchange ramp terminal and the signalized full-movement intersection for the planned future collector roadway.

Solution:

- Because the intersection of the ramp terminal with the arterial cross road is signalized, the traffic signal spacing guidelines presented in *Chapter 7* were applied to determine the location of the new signalized intersection between the arterial and the planned future collector.

- The traffic signal spacing decision tree shown in *Figure 7-1* were consulted to determine the appropriate guidelines to apply under these circumstances. As described above, the proposed traffic signal is not part of a Port Authority redevelopment program, but is warranted based on the results of the engineering study.

- Because there are no traffic signals within one mile in either direction – and the Port Authority has indicated that the desired signal control strategy is to optimize vehicle progression – the speed and cycle length table (*Table 7-1*) was consulted to determine the spacing of the planned signalized arterial/collector intersection from the existing signalized intersection between the ramp terminal and the arterial. According to *Table 7-1*, for a progression speed of 35 mph and a cycle length of 60 seconds, the traffic signal spacing along the arterial cross road is 1,540 feet (approximately 0.3 miles).

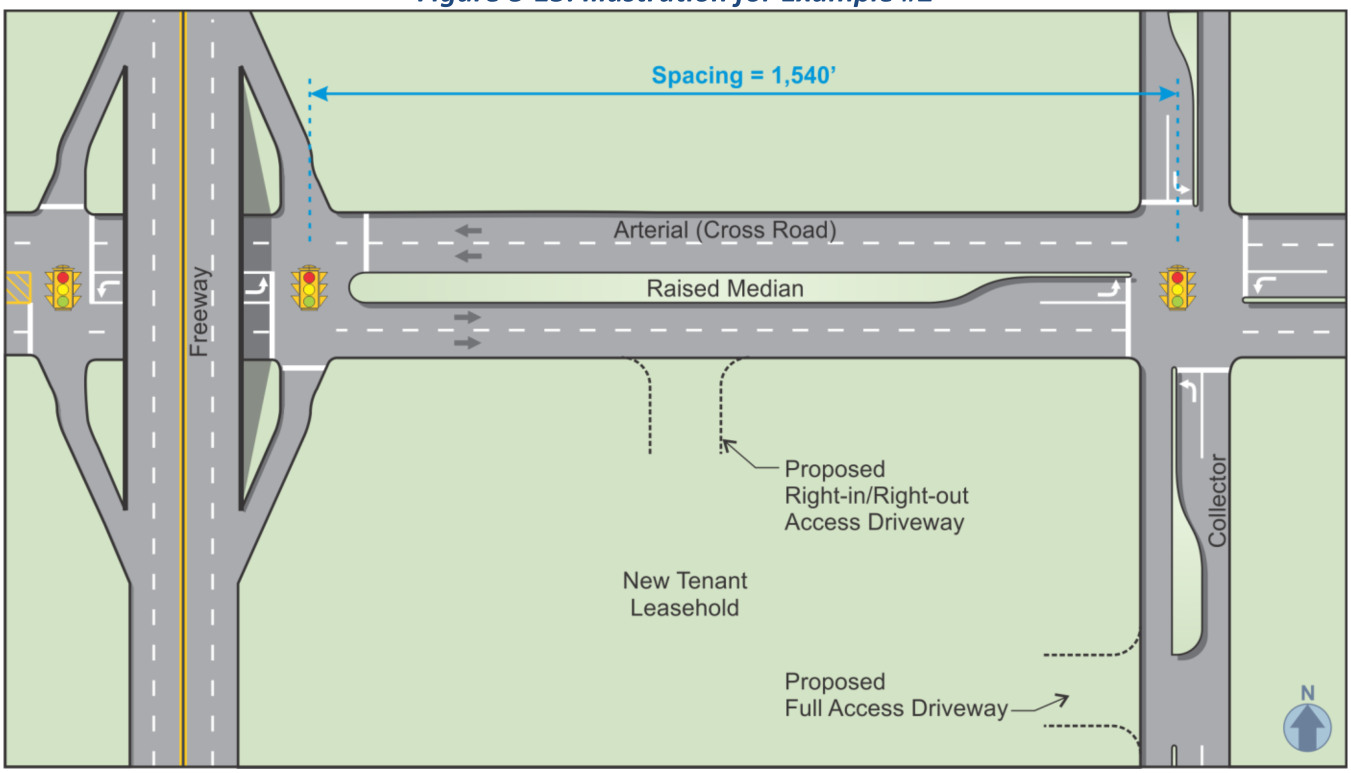
- Therefore, the desirable spacing between the interchange ramp terminal and the signalized full-movement intersection is 1,540 feet.

8.3.2 Example #2: Spacing from Signalized Ramp Terminal to First Downstream Right-In/Right-Out Driveway

Given:

- The roadway configuration illustrated in Example #1, assuming construction of the collector roadway and signalization of the arterial/collector intersection.
- A new tenant is expected to lease and develop Port Authority property on the south side of the arterial, as shown in *Figure 8-15*. The tenant desires a full-access driveway on the west side of the collector, as well as right-in/right-out access driveway on the eastbound direction of the arterial.
- Operational analysis of the traffic signals shows that, under projected future traffic conditions, the 85th percentile vehicle queue on the eastbound approach to the arterial/collector intersection is 300 feet.

Figure 8-15: Illustration for Example #2



Problem: Find the recommended location for the new tenant's proposed right-in/right-out driveway on the eastbound direction of the arterial.

Solution:

- To determine the location of the tenant's right-in/right-out driveway on the arterial, the corner clearance distances relative to the traffic signals on either side of the tenant's proposed driveway were verified according to the procedures in *Chapter 6: Corner Clearance*.
- Because the interchange cross road is an arterial, *Table 6-2* was consulted to identify the desirable corner clearance distance from the upstream and downstream signalized intersections. The "non-traversable median" case was applied due to the presence of the raised (i.e., non-traversable) median.

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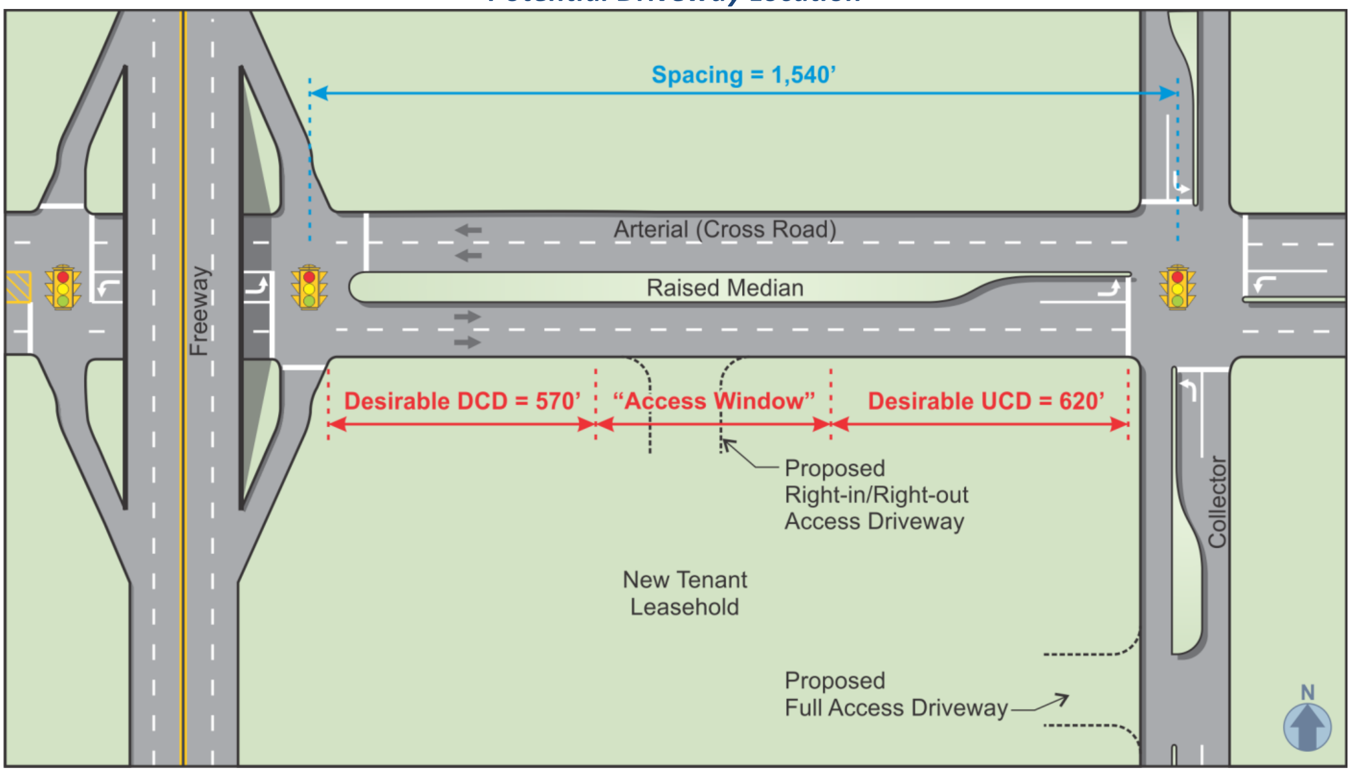
- Based on the guidance in *Table 6-2*, the desirable UCD and DCD are as follows:

  Downstream Clearance Distance (DCD) from interchange ramp terminal:
  - Desirable Distance[27] = **570 feet**

  Upstream Clearance Distance (UCD) from arterial / collector intersection:
  - Desirable Distance = (PIEV + M + D Distance) + 85th Percentile Queue Length
    = 320 feet + 300 feet = **620 feet**

Given the spacing along the arterial between the intersections with the ramp terminal and the collector roadway, the tenant's right-in/right-out driveway can be located anywhere within the "access window" shown in *Figure 8-16* and still meet the desirable upstream and downstream corner clearance distances identified above.

Figure 8-16: Example #2 – Desirable Corner Clearances and "Access Window" for New Tenant's Potential Driveway Location



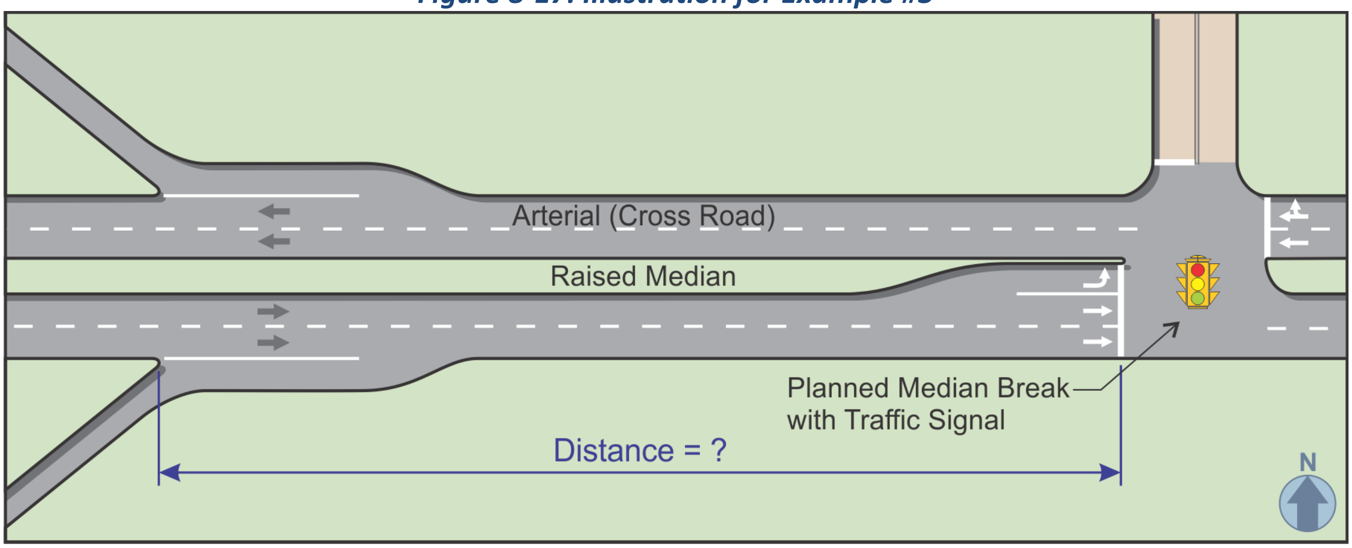
27 Based on desirable unsignalized driveway spacing distance (see *Table 5-1*).

8.3.3 Example #3: Spacing from Free-Flow Ramp Terminal to First Full-Movement Driveway

Given:

- A grade-separated interchange between an arterial cross road and a freeway. All freeway ramps connect to the arterial via free-flow merges (see *Figure 8-17*).
- The arterial is divided by a non-traversable median with two lanes in each direction. The posted speed on the arterial is 35 mph.
- A median break is desired to accommodate a full-movement, signalized access driveway on the arterial, some distance east of the interchange. There are currently no other driveways along the arterial.
- Due to high existing traffic volumes along the arterial, the driveway will need to include an exclusive left-turn lane on the eastbound approach. Operational analysis of the driveway under projected future traffic conditions indicates that the left-turn lane requires storage for a 95th percentile vehicle queue of 200 feet and that the 95th percentile queue in the adjacent (eastbound) through lanes is 300 feet.
- Based on guidance in the AASHTO "Green Book," the median transition taper into the left-turn lane is determined to be 100 feet.

Figure 8-17: Illustration for Example #3



Problem: Find the desirable spacing distance along the arterial between the free-flow ramp and the proposed full-access driveway.

Solution:

- Based on the guidance in *Table 8-1*, the distance needed for vehicles to merge onto the arterial from the on-ramp and merge across two lanes on the arterial is 1,200 feet.
- Based on the guidelines in *Section 8.2.2.1* of this chapter, calculate the desirable spacing distance as follows:

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Desirable Spacing Distance to First Full-Movement Driveway

= (Merging and Weaving Distance) + Decision Distance + Transition Distance + Queue Storage Distance[28]

= 1,200 feet + 625 + 100 feet + 300 feet

= 2,225 feet

The decision distance was identified from the values in *Table 8-2*. Based on a posted speed of 35 mph, the decision distance to be added is 625 feet.

If the desirable distance between the off-ramp and the proposed driveway (i.e., 2,225 feet) cannot reasonably be achieved, property access strategies described in *Chapter 13* should be investigated or a design exception would be needed for the proposed driveway location. (See *Chapter 14* for more guidance relative to general design exception criteria.)

[28] 95th percentile queue is greater of: A) the queue in the exclusive left-turn lane, and B) the queue in the adjacent through lane(s).

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CHAPTER 9: DRIVEWAY DESIGN

9.1 Overview

Driveways are roadway connections that provide vehicular access between roadways and abutting properties or leaseholds within Port Authority facilities. For purposes of this chapter, the term "driveway" also includes the space in the immediate vicinity of the physical connection between the driveway and the roadway. This chapter does not address the design of drive aisles within a site or leasehold area, except where such a design affects the intersection of the driveway with the Port Authority roadway.

Driveways are integral to the roadway transportation system. Every driveway connection to a Port Authority roadway creates an intersection, which, in turn, creates conflicts for the motorist with bicyclists, pedestrians, and other motor vehicles. Proper driveway design balances the needs of all users by minimizing conflicts while accommodating the demands for mobility and access. The designer should consider the following factors in the design of driveways:

- Driveway setting and location
- User mix and attributes, by mode (passenger cars, trucks, bicyclists, pedestrians, pedestrians with disabilities)
- Dimensions and turning paths of design vehicles (passenger cars, trucks, buses)
- Design volumes (especially peak hour trips, by mode)
- Design vehicle speed
- Intersection sight distance
- Pedestrian walking speed

This chapter contains guidelines for the geometric design of driveways, with the following objectives in mind:

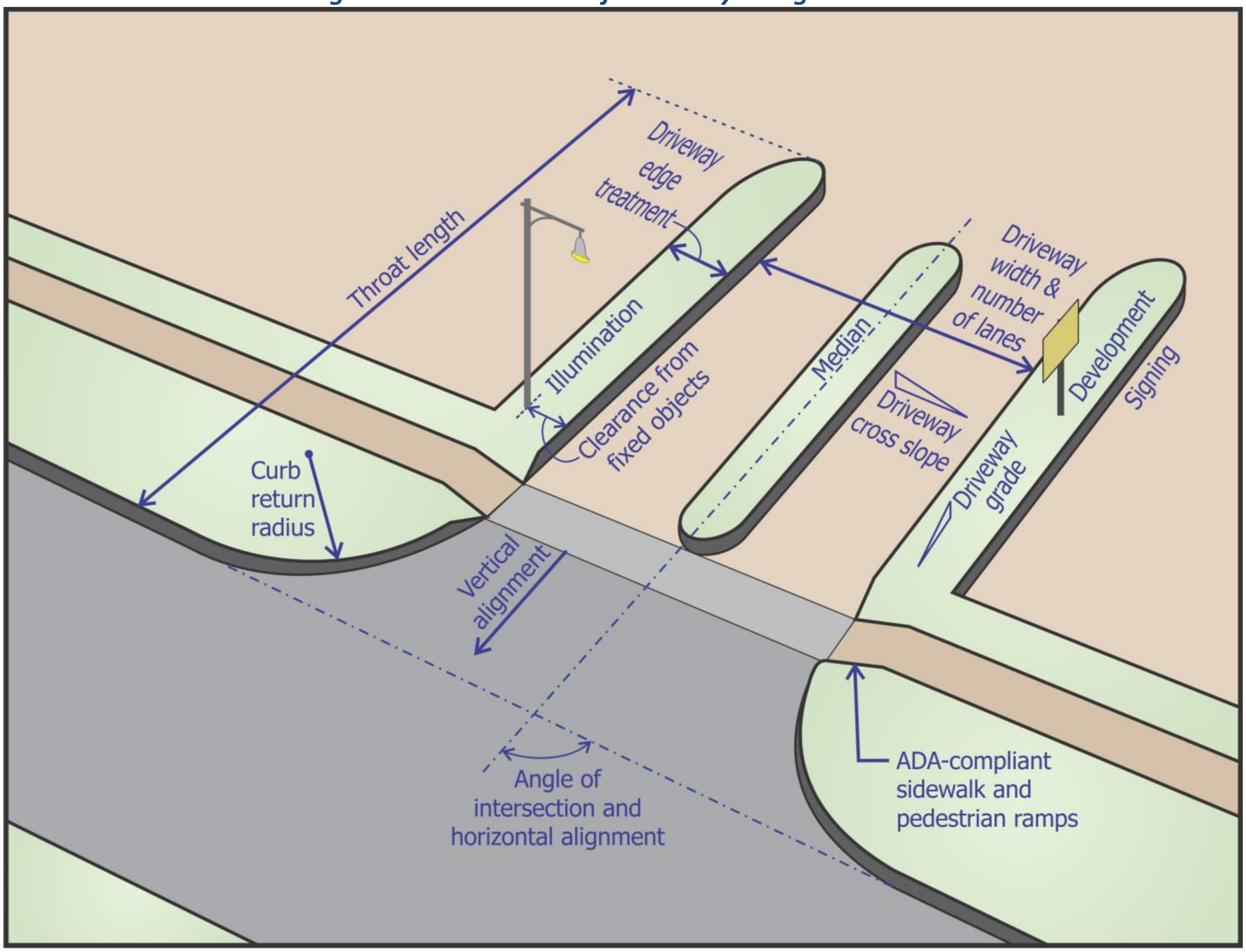
- Promoting a safe environment for various users including motorists, bicyclists, and pedestrians (including both transit passengers and pedestrians with disabilities)
- Providing a geometry that accommodates the characteristics and limitations of the various users, and avoiding geometric conditions that create traffic operational problems
- Providing driveways that allow traffic to flow smoothly
- Providing driveways that are conspicuous and clearly delineated for the various users

To achieve these objectives, design guidelines for the following driveway design features, shown in *Figure 9-1*, are addressed in this chapter:

- Width and number of lanes
- Curb return radius and throat transition geometry
- Throat length and internal site queue storage
- Angle of intersection and horizontal alignment
- Non-traversable medians and islands located on the driveway
- Cross-slope
- Driveway edge treatment

- Clearance from fixed objects
- Vertical alignment and grade
- Development signing
- Illumination

Figure 9-1: Illustration of Driveway Design Features



Other chapters of these *Guidelines* address: driveway spacing (*Chapter 5*) and intersection sight distance (*Chapter 10*), as well as left-turn lanes (*Chapter 11*) and right-turn lanes (*Chapter 12*) on the Port Authority roadway, as opposed to on the driveway.

9.2 Guidelines

The application of these *Guidelines* to the driveway design is an item to be discussed with Port Authority Engineering at the team conceptual planning meeting.

9.2.1 Driveway Width and Number of Lanes

The width of a driveway is a function of the physical space needed to accommodate all driveway users and design vehicles. To determine the driveway width, the designer should consider:

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- the number of lanes
- the widths of those lanes
- the presence and width of a median on the driveway
- the needs of motorized, pedestrian, and bicycle traffic.

Although a wider driveway with more lanes may increase the vehicular capacity and accommodate the turning paths of larger vehicles turning into and out of the driveway, it also increases the time necessary for pedestrians to cross the driveway, thereby increasing their exposure to conflicts with motorized vehicles. Because of these design trade-offs, the designer should balance the competing needs of reducing vehicle delay by adding lanes and limiting pavement width and facilitating pedestrian crossings.

It is assumed that two-way driveways have at least two lanes: one lane entering the property and one lane exiting. However, as traffic volumes increase, the addition of a second exit lane should be considered to avoid excessive delays and queuing on the driveway. Without two exit lanes at a STOP-controlled driveway, for example, a motorist wanting to turn left blocks others in the queue from exiting.

If it is determined at the team conceptual planning meeting that the number of driveway lanes needs to be determined by a transportation study, *Section 2.6.3* can be consulted for a sample scope. As part of the determination of the optimum driveway configuration, the traffic study should examine the traffic control devices (e.g., STOP signs, traffic signals, etc.) and allowable vehicle movements (e.g., left-turns, through movements, and right-turns) at all access points to the subject property or properties.

An *open frontage*, a wide-open, undefined driveway across the full frontage of the property, as shown in *Photos 9-1* and *5-1,* should be avoided. The undefined lane arrangement of an open frontage results in motorists lacking positive guidance, allowing them to enter and leave the property at any location. As such, vehicles on-site are exposed to incoming and outgoing traffic, with no safe refuge. These designs are also particularly unfriendly to bicyclists and pedestrians. This situation creates many more conflict points (including those involving pedestrians and bicyclists) than a well-defined driveway.

Photo 9-1: Undesirable "Open Frontage"

Photo source: Google Earth™ mapping service

In summary, the following guidance shall apply when determining the driveway width and number of lanes at driveways along Port Authority roadways:

- The design for the entry and exit lane geometry for all driveways along Port Authority roadways should:
  - provide adequate driveway capacity, including exclusive left-turn and right-turn exit lanes where needed (*see Figure 9-2*)
  - reflect the needs of all users, including pedestrians and bicyclists, in determining the driveway width
  - define a shape that conforms to the path of the turning vehicle, preventing vehicles from encroaching into other lanes (see *Figure 9-3*)
  - enable vehicles to enter the driveway without significantly impeding the upstream flow of through traffic on the roadway (see *Figure 9-3*).
- If it is determined at the team conceptual planning meeting that the number of driveway lanes needs to be determined by a transportation study, *Section 2.6.3* can be consulted for a sample scope.

Figure 9-2: Driveway with Exclusive Left-Turn and Right-Turn Lanes

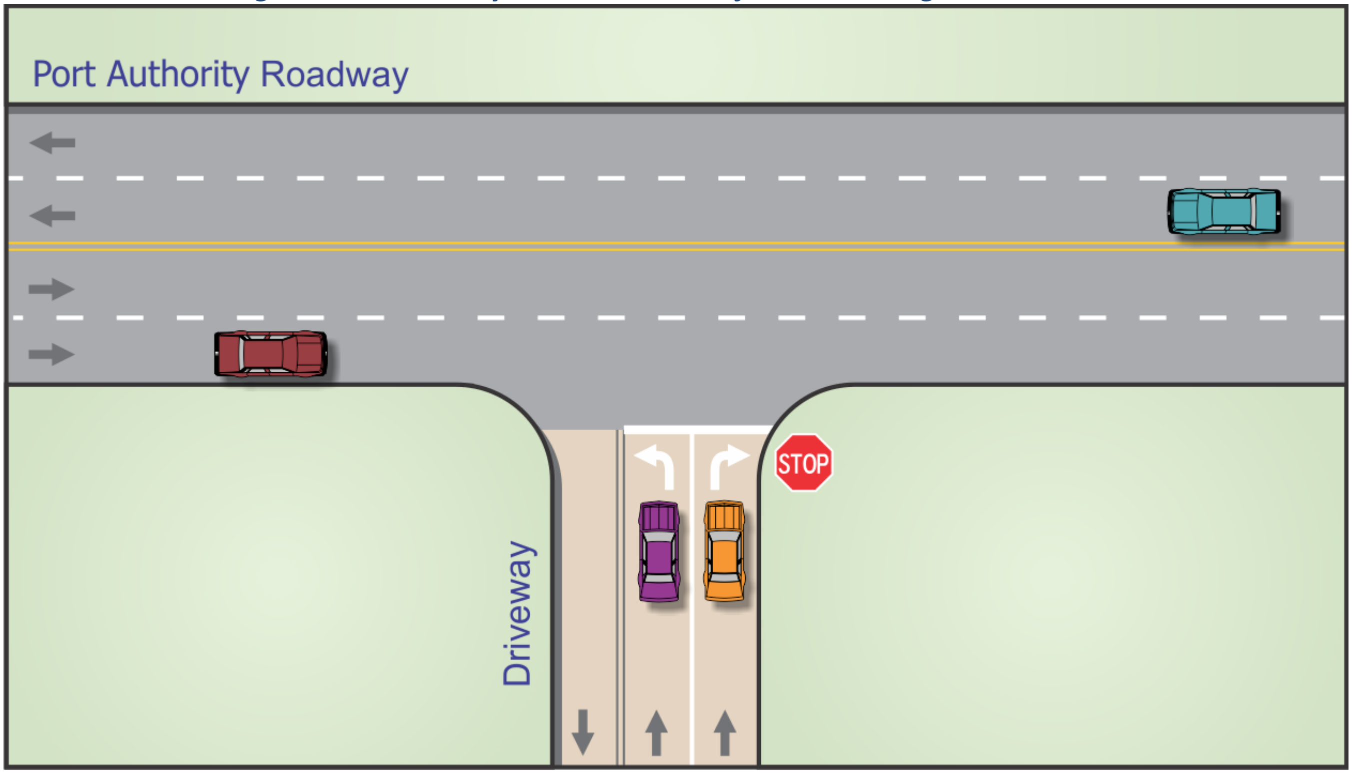
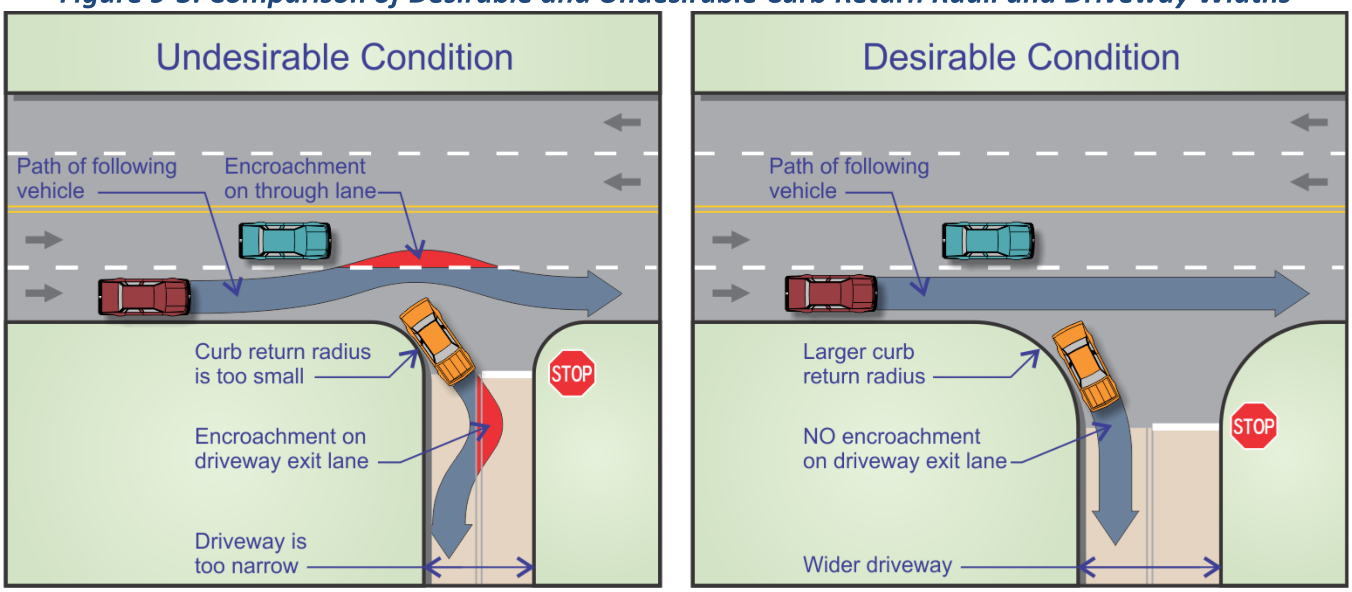


Figure 9-3: Comparison of Desirable and Undesirable Curb Return Radii and Driveway Widths



In addition:

- Open frontages should be avoided.
- The number of lanes exiting from the driveway and turning in one direction should not exceed the number of available traffic lanes on the roadway in that direction. For example, for a driveway intersecting a two-lane, two-way roadway, no more than one left-turn lane and one right-turn lane would be allowed on the driveway approach to the intersection. Where double turn lanes are provided, the receiving lanes should be designed to accommodate two design vehicles located side-by-side turning simultaneously, without these vehicles encroaching into the travel lanes for traffic traveling in the opposing direction or in the

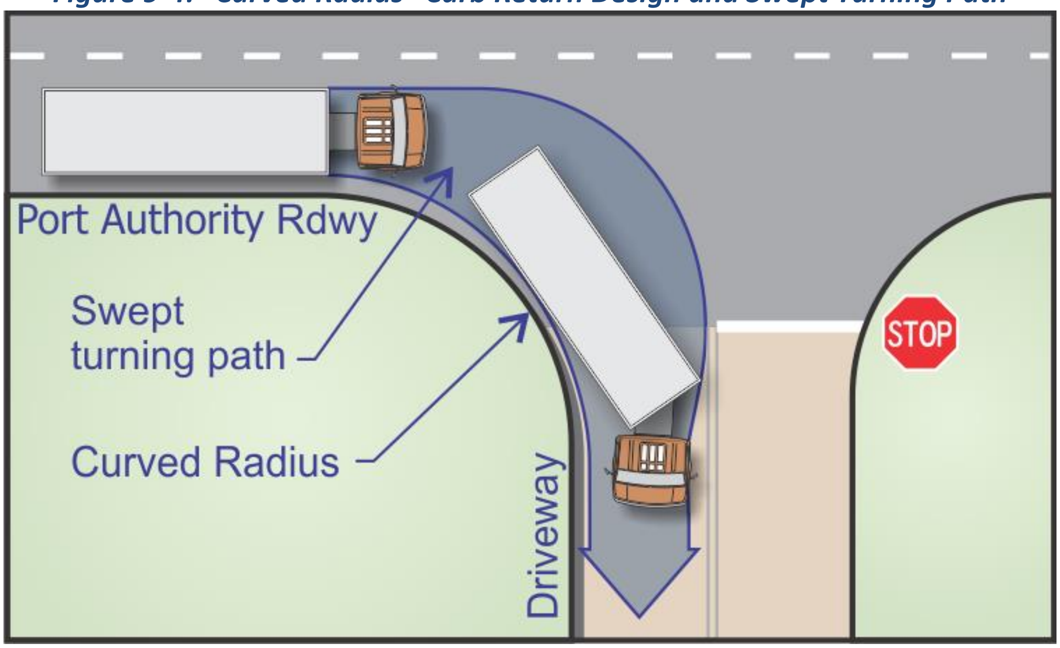
adjacent turn lane.

9.2.2 Curb Return Radius and Throat Transition Geometry

For a driveway to intersect a Port Authority roadway, a break in the curb line or the edge of the roadway is needed. The following guidance shall apply to the design of all driveways along Port Authority roadways:

- A curved radius design (see *Figure 9-4*) should be used, unless the driveway meets the design requirements provided for a "taper layout" at a "Minor Commercial" driveway as specified in the New York State Department of Transportation's *Policy and Standards for the Design of Entrances to State Highways*.[29]
- The curb return radius should be designed to accommodate the swept turning path of the design vehicle (see *Figure 9-4*). The designer should verify that the turning path of the design vehicle does not over-track the corner.[30]

Figure 9-4: "Curved Radius" Curb Return Design and Swept Turning Path



- Driveways may also be constructed to include a wider cross-section close to the intersecting roadway, with the driveway width tapering to a narrower section some distance back from the intersecting roadway (see *Figure 9-5*). This type of throat transition geometry may be incorporated into the design of the driveway to accommodate the off-tracking and swept paths of very large turning vehicles (e.g., tractor-trailers) entering and exiting the driveway. The design will require a transition from the wider cross-section width to the narrower cross-section width.

[29] See Section 5A.10, and Figures 5A-1 through 5A-5, of the November 24, 2003 NYSDOT *Policy and Standards for the Design of Entrances to State Highways*:https://www.dot.ny.gov/divisions/operating/oom/transportation-systems/repository/Policy%20and%20Standards%20for%20the%20Design%20of%20Entrances%20to%20Stat.pdf

[30] Software, such as AutoTurn™, may be used to identify the swept path for a given design vehicle.

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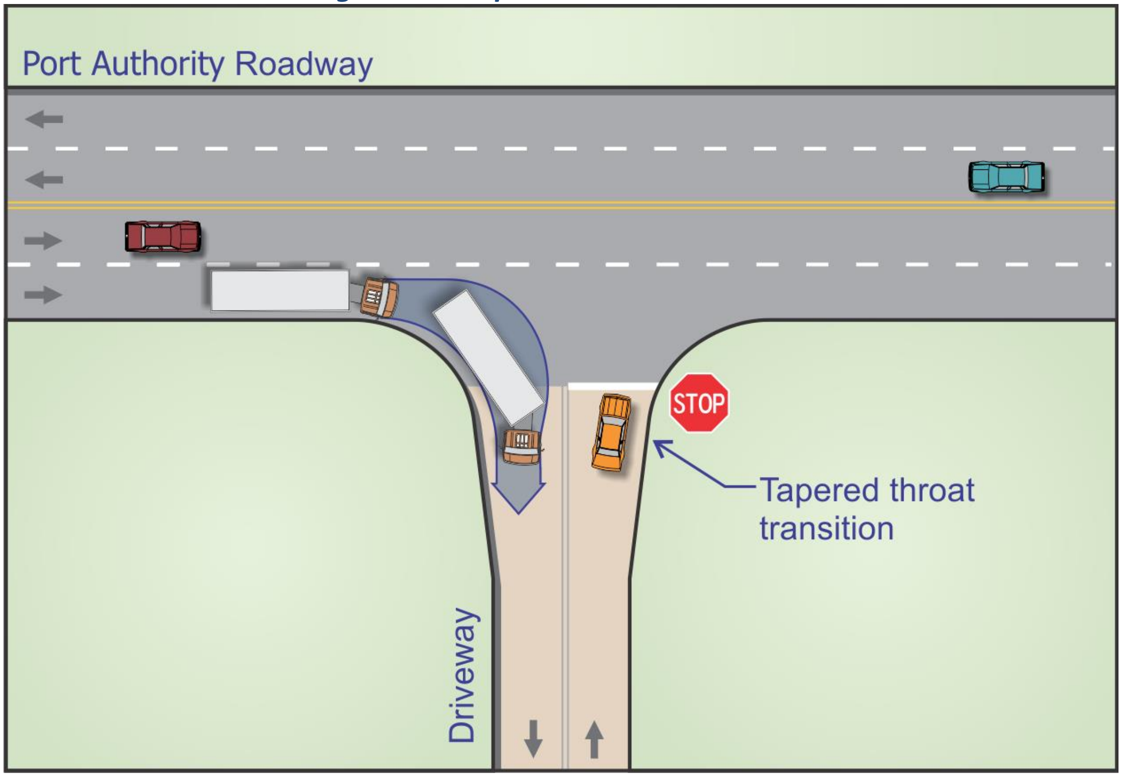
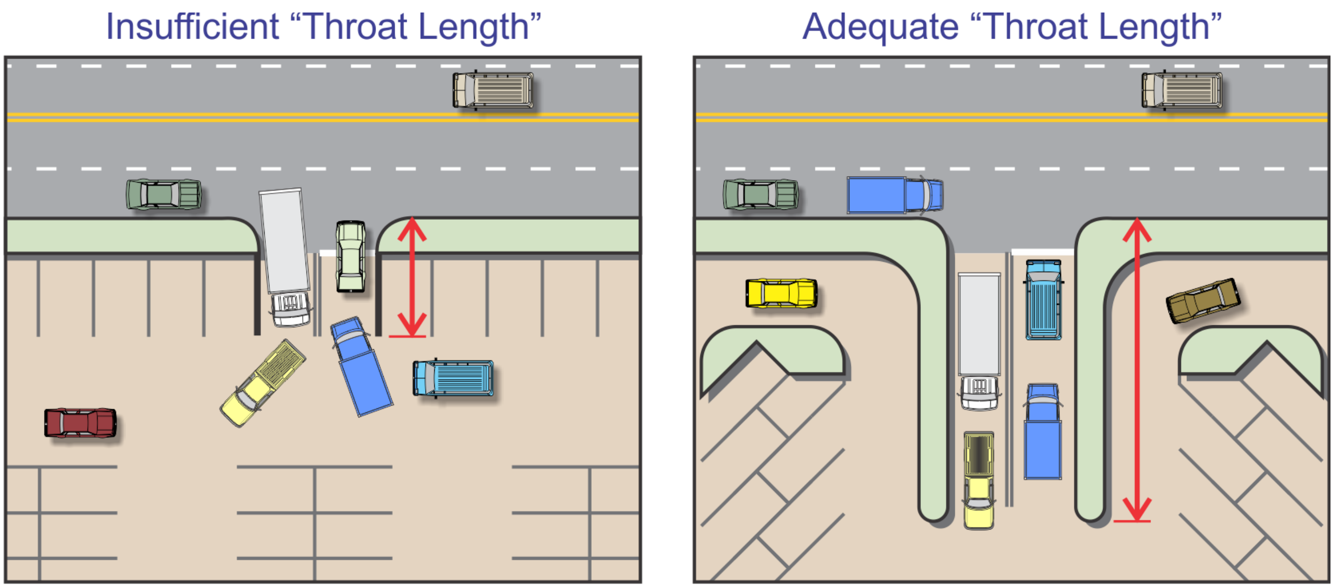
Figure 9-5: Tapered Throat Transition



9.2.3 Throat Length and Internal Site Queue Storage

The *throat length* of a driveway is the storage length available that is free of conflicts for vehicles entering and leaving the driveway. It is measured from the outer edge of the traveled way of the intersecting roadway to the first point at which there are conflicting traffic movements on the subject property or leasehold served by the driveway. As shown on the left side of ***Figure 9-6***, in locations with insufficient throat length, drivers entering the site may be forced to stop or slow down in order to turn within the site or maneuver around queued vehicles waiting to exit. These conditions have the propensity to generate queues that spill back onto the roadway, causing an operational problem that should be avoided through proper driveway design. In addition, vehicle queues of motorists waiting to exit the property can spill back into the site and obstruct the free movement of traffic within the site.

Figure 9-6: Insufficient versus Adequate Throat Lengths



Thus, throat lengths for all driveways along Port Authority roadways should be designed to provide adequate storage distance to accommodate the 95th percentile queue length[31] for both:

1) vehicles *entering* the driveway (as determined from a queuing analysis of internal site operations[32]) to reduce the propensity for queue spill-back onto the roadway, and
2) vehicles *exiting* the driveway (as determined through a capacity analysis of the driveway/roadway intersection) to reduce traffic congestion on the subject property.

Of the two conditions above, the former is typically more critical than the latter, due to the potential for a more severe crash associated with higher-speed traffic on the roadway conflicting with slower-speed vehicles turning into the driveway. Although a traffic queue that backs up into a property may generate congestion on that property, the congestion is generally limited to the property, speeds are generally lower, and the crash potential is not as severe. Therefore, the designer should give priority to ensuring that vehicles entering the driveway do not spill back onto Port Authority roadways.

9.2.4 Angle of Intersection and Horizontal Alignment

Whereas throat length is related to the overall storage distance needed to accommodate vehicle queues entering and exiting the driveway, the distance needed for the *horizontal alignment* is related to the *geometric alignment of the driveway* at its intersection with the roadway. Driveways that intersect the roadway at angles much less than 90 degrees are undesirable because they are more difficult for drivers to navigate. Smaller angles cause drivers greater difficulty in turning their heads to scan the roadway for an adequate gap in traffic, resulting in more distance and time required to complete the turning movement.

Also, a horizontal driveway alignment that is straight through the connection transition area (i.e., near the driveway's intersection with the roadway) provides the following advantages over a curved alignment:

[31] The 95th percentile queue length represents the distance that would not be exceeded by a queue of vehicles 95 percent of the time during the analysis period.
[32] Internal site operations should consider the location of entrance gates, guard booths, etc.

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- Improves the efficiency and capacity of the driveway by reducing the follow-up time required for vehicles waiting in queue. Vehicles behind the first vehicle in the queue are already positioned to move straight ahead.

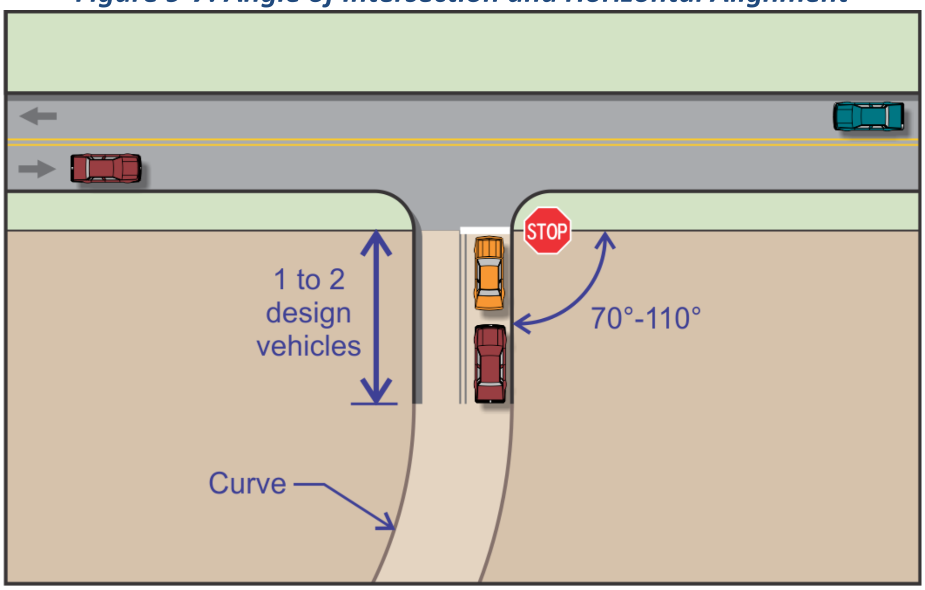
- Eliminates the added driving task of steering through one or more curves when entering or leaving the driveway. These actions divert a driver's attention from other driving tasks such as monitoring crossing bicyclists, pedestrians, and other vehicles.

- Makes it easier for drivers to position and align their vehicles as they approach the intersection, avoiding sideswiping other vehicles when they make turning maneuvers.

The following guidance shall apply to the horizontal alignment design of all driveways along Port Authority roadways:

- All two-way driveway approaches to Port Authority roadways should intersect the roadway at angles of between 70 and 110 degrees (see *Figure 9-7*).

Figure 9-7: Angle of Intersection and Horizontal Alignment



- One-way/right-out driveways should intersect with the roadway at angles of from 90 to 120 degrees to facilitate the right-out exiting movement.
- The driveway's horizontal alignment should include a minimum tangent section before any curvature. The desirable length of this tangent section should be two design vehicles (see *Figure 9-7*).

9.2.5 Non-Traversable Medians and Islands located on the Driveway Approach

Non-traversable median islands can provide several benefits, but they can also complicate snow removal and obstruct the turning paths of very large trucks. The benefits of non-traversable median islands include the following:

- Physically separating traffic traveling in opposing directions

- Guiding vehicular traffic in the intended direction of travel

- Reducing wide areas of pavement
- Reducing pedestrian crossing distances
- Providing a refuge for pedestrians
- Providing a location for the placement of signs (which is compliant with sight distance triangles)
- Allowing for landscaping (which is compliant with sight distance triangles)

The following guidance shall apply to the use of non-traversable median islands on driveway approaches to all Port Authority roadways:

- A non-traversable median on the driveway may be considered where a driveway has any of the following:
  - two or more entrance lanes
  - two or more exit lanes
  - a large pavement area that could confuse drivers
  - right-in/right-out operation, which may be unclear to some drivers
  - high traffic volume or
  - existing or future traffic signal control.
- The desirable *width* of the non-traversable median island in the driveway should be 6 feet.
- The desirable *length* of the non-traversable median island in the driveway should be 50 feet, so that it is prominent enough to be clearly recognized by motorists.

9.2.6 Cross-Slope

Pavement cross-slope is an important cross-sectional design element. The cross-slope drains water from the roadway laterally and helps minimize ponding of water on the pavement. The typical cross-slope is 1.5 percent to 2.5 percent. Driveways crossing a sidewalk should be designed so that both pedestrians and drivers are able to traverse the sidewalk-driveway crossing. Guidance related to the design of the driveway cross-slope, including American with Disabilities Act (ADA) requirements, is available from Port Authority Engineering.

9.2.7 Driveway Edge Treatment

Defining the driveway edge helps all users ascertain the lateral limits of motor vehicle operation at the driveway. The edge of all driveways along Port Authority roadways should be clearly defined and visible to all users (including drivers, pedestrians, and bicyclists) through the use of striping, curbs, reflectors, and/or other similar devices that help increase visibility.

9.2.8 Clearance from Fixed Objects

Fixed (non-breakaway) objects – such as utility poles and retaining walls – should be set back from the edge of the driveway by a lateral offset (see *Figure 9-8*). The lateral offset distance allows clearance for vehicle side mirrors and accounts for possible off-tracking of the wheel and body paths of turning vehicles. The following guidance shall apply to clearance from fixed objects at all driveways along Port Authority roadways:

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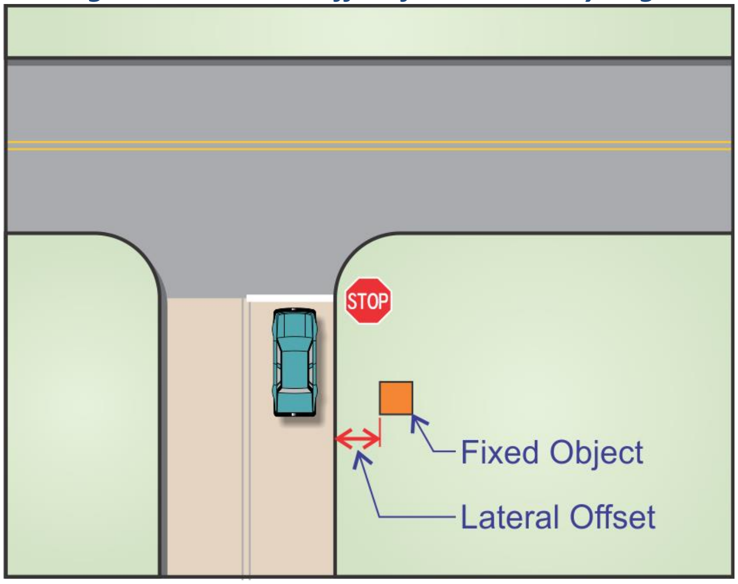
Figure 9-8: Lateral Offset from Driveway Edge



- Fixed (non-breakaway) objects should be set back from the edge of the driveway by a lateral offset distance. The lateral offset distance is measured perpendicularly from the face of the curb along the driveway to the nearest point on the fixed object.
- The desirable lateral offset distance on both sides of all driveways should be 5 feet.
- In undeveloped areas[33] or developing areas[34], the minimum lateral offset distance on both sides of all driveways should be 2 feet. In developed areas[35] where the sidewalk width is limited, or where existing utility poles are located close to the curb, the minimum lateral offset distance on both sides of all driveways should be 1.5 feet.
- The designer should consider the specific usage of the driveway and the needs of the subject property to determine the length of the driveway throat to which the lateral offset distance applies.
- Wheel and body paths for design vehicles should be verified by the designer[36], such that they do not over-track beyond the edge of the driveway.

9.2.9 Vertical Alignment and Grade

Because changes in vertical profile are often found at driveway entrances, these locations can cause damage to the undercarriage of the vehicle as well as to the pavement surface (see *Photo 9-2*). Large differences between successive grades – or an abrupt change of grade – at the driveway creates crests and sags that can cause the underside of a vehicle to drag. Any excessive grade change between the cross slope of the roadway and the driveway grade, between the driveway grade and an intersecting sidewalk, or between successive driveway grades can cause this undesirable vehicle drag.

[33] An undeveloped area is one characterized by one or more of the following features: (a) little to no roadside development, (b) few, if any, intersecting driveways and roadways, (c) right-of-way available for roadway improvements, and/or (d) little to no pedestrian activity.

[34] A developing area is one that is (or will be) undergoing changes related to roadside development activity. These areas are typically characterized by one or more of the following features: (a) roadside development that is planned, imminent, or already taking place, (b) a growing number of driveways and intersecting roadways, (c) increasing pedestrian activity, and/or (d) a need to consider transit.

[35] A developed area is one that is characterized by one or more of the following features: (a) dense roadside development, (b) a substantial number of existing intersecting roadways, (c) limited right-of-way available for roadway improvements, (d) existing environmental and/or topographic constraints, and/or (e) significant pedestrian or transit considerations.

[36] Scaled vehicle turning templates or software, such as AutoTurn™, can be used for this purpose.

Photo 9-2: Undercarriage Scraping at Driveway due to Inadequate Vertical Profile

Photo source: *NCHRP Report 659: Guide for the Geometric Design of Driveways*, 2010, Exhibit 5-66, p. 69.

In addition, vehicles with a particularly low ground clearance and a long wheelbase or overhang can become lodged on alignments with sharp grade changes. It is also possible that a vehicle will be overloaded or follow an unusual or out-of-the-ordinary path in negotiating the driveway, further reducing ground clearance and resulting in dragging.

Furthermore, changes affecting the effective ground clearance at a driveway may occur over time. For example, as Port Authority leaseholds change hands or as redevelopment occurs, the land uses served by a driveway may change, resulting in the driveway being used by different types of vehicles than those for which it was originally designed. In addition, the vertical profile of the driveway itself is also subject to change. As the roadway is milled or resurfaced, its elevations and cross-slopes change. Also, the roadway, driveway, and associated features (such as sidewalks) may deform over time due to applied loads, the effects of weather, or other causes.

The issues described above are particularly acute at driveways that intersect with high-volume or high-speed roadways. Excessive differences in speed between the through vehicles on the roadway and the vehicles turning into or out of the driveway – due to the vertical profile – can increase the propensity for crashes. In addition, bumps, steep grades, and abrupt changes in grade due to poor vertical alignment can cause discomfort to vehicle occupants. Dragging results in motorist discomfort, vehicular delay, and/or minor damage to the undercarriage of the vehicle and to the pavement surface.

While additional research is needed with respect to the vertical alignment of driveways (particularly regarding the ground clearance characteristics of various vehicle types that make up the motor vehicle population), the designer should observe vertical design guidelines. The designer should consider the following factors in the design of driveways:

- To design the vertical alignment elements of a driveway, the designer should determine an appropriate design vehicle and its corresponding dimensions, including the wheelbase and front and rear overhangs. This design vehicle should be identified based on the anticipated population of vehicles expected to use the driveway. The design vehicle used for purposes of designing the vertical alignment may be different

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from the design vehicle used to design the horizontal alignment (i.e., for turning radius purposes).

- Driveways should be designed to avoid the underside of the design vehicle dragging on the roadway or driveway surface. The vertical alignment of the driveway should allow for a convenient entry with minimal conflicts. To achieve these objectives, grade changes should not be abrupt.
- The designer should have a complete understanding of the vertical driveway profile to be negotiated by the design vehicle. This includes, for example, the roadway cross slope, the driveway grade line, and other controls (e.g., locations and elevations of intersecting sidewalks).
- The vertical profile(s) used in the design of the driveway should reflect the horizontal turning movement paths expected to be used by the design vehicle.
- As Port Authority leaseholds change hands or as redevelopment occurs over time, the types of vehicles using the driveway should be considered with respect to the needed vertical profile of the driveway. Design modifications to the vertical alignment of the driveway should be undertaken when deemed necessary to maintain or improve the vertical profile for the design vehicle.

9.2.10 Development Signing

Signs, when located close to a driveway, help drivers who are scanning the upcoming roadside to detect the location of the driveway serving their destination. Conversely, a business sign located far from the subject property's driveway may actually divert a driver's view away from the driveway location, be misleading or even be confusing, thereby increasing the possibility of drivers making errors and also increasing the likelihood of a crash.

The need to provide information to the driver in a timely manner is critical because the driver may have to negotiate heavy traffic volumes and may not be able to change lanes or decide quickly on when and where to make turns. However, motorists may also be faced with numerous competing signs and traffic control devices. As a result, there is a balance between providing drivers with sufficient information and not overwhelming them with too much information.

The following guidelines apply to the signing of driveways along Port Authority roadways:

- Signs to direct motorists to businesses located on Port Authority leaseholds should be located and positioned in a manner that helps clearly identify the entrance driveway(s) serving the subject property.
- All business signs should be placed so that they:
  - do not obstruct sight lines (see *Chapter 10*)
  - do not compete with traffic signs
  - do not protrude into sidewalks or other pedestrian areas and
  - are not obstructed by signal poles, street lights, other signs, or other roadside appurtenances
- Signs should be installed sufficiently far from the curb to prevent contact with vehicles.
- Signs should be lighted or have reflective properties such that they are visible at night, during inclement weather, and under poor ambient lighting conditions.
- The design and placement of business signs should be subject to the guidelines presented in the other sections of this chapter (i.e., *Section 9.2.8: Clearance from Fixed Objects*), as well as the intersection sight distance and roadside buffer guidelines in *Chapter 10*.
- Chapter 2D, "Guide Signs – Conventional Roads" in the *Manual on Uniform Traffic Control Devices* applies to guide signs used to direct users to destinations within Port Authority facilities.

- The Port Authority's *Airport Roadway Sign Design Manual* should be consulted for additional signing guidance at airport facilities.
- Tenants shall keep landscaping (e.g., grass, flowers, shrubs, and trees) trimmed and pruned so that drivers have a clear view of signs needed by drivers to identify the locations of the business and the location of the entrance driveways. These provisions should be included in leasehold agreements whenever possible.

9.2.11 Illumination

Statistics indicate that nighttime crash rates are higher than crash rates during daylight hours. This fact, to a large degree, may be attributed to lower visibility. In locations without adequate lighting, drivers traveling at night, during inclement weather, or under poor ambient lighting conditions may not be able to identify the access driveway to a business or leasehold. In addition, the lack of proper illumination may prevent drivers from seeing pedestrians, bicyclists, and other vehicles at adequate sight distances. The following guidelines apply to the illumination of driveways along Port Authority roadways:

- Adequate illumination[37] should be provided in the vicinity of all intersections and driveways to provide for the necessary sight distances for all users of the driveway, including motorists, pedestrians, and bicyclists. The necessary level of illumination should be based on consideration of the following factors:
    - traffic, pedestrian, and bicycle volumes
    - vehicle speeds
    - nighttime crash history
    - intersection geometrics and
    - general nighttime visibility
- Illumination should be installed where any of the following conditions exist:
    - potential for wrong-way movements, as indicated through crash experience or engineering judgment
    - high pedestrian or bicyclist volumes
    - need for motor vehicle travel path adjustment at or near the intersection due to a shifting lane alignment, a turn-only lane assignment, or a pavement width transition
- The following illumination criteria[38] should apply irrespective of the type or classification of the roadway:
    - 150-Watt High-Pressure Sodium at 26 feet
    - 250-Watt High-Pressure Sodium at 40 feet
    - Average maintained: 0.6 to 0.9 foot-candles
    - Light loss factor: 0.75 foot-candles
    - Minimum: 0.2 foot-candles
    - Average/Minimum: 4:1 or better
    - Conventional Cutoff Cobra head

[37] The reader is referred to AASHTO's *Roadway Lighting Design Guide* (2005 or superseding edition) for more information on roadway illumination.

[38] Criteria for illumination provided by Harshad N. Patel in Port Authority Electrical Engineering Discipline of the Engineering Department.

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CHAPTER 10: ROADSIDE BUFFER AND INTERSECTION SIGHT DISTANCE

10.1 Roadside Buffer

10.1.1 Overview

As shown in *Figure 10-1*, the "roadside buffer" is defined as the area starting at the edge of the traveled way and extending away from the roadway centerline a horizontal distance specified in *Section 10.1.2*. The desired width of the roadside buffer is dependent upon the design speed of the roadway. The purpose of the roadside buffer is to provide space for:

- placing and maintaining utilities,

- locating roadside guide signs, and

- having a recovery area for errant vehicles that leave the shoulder.

Figure 10-2 illustrates the roadside buffer when no shoulder is present.

Figure 10-1: Illustration of Roadside Buffer and Clear Zone on a Roadway with a Shoulder

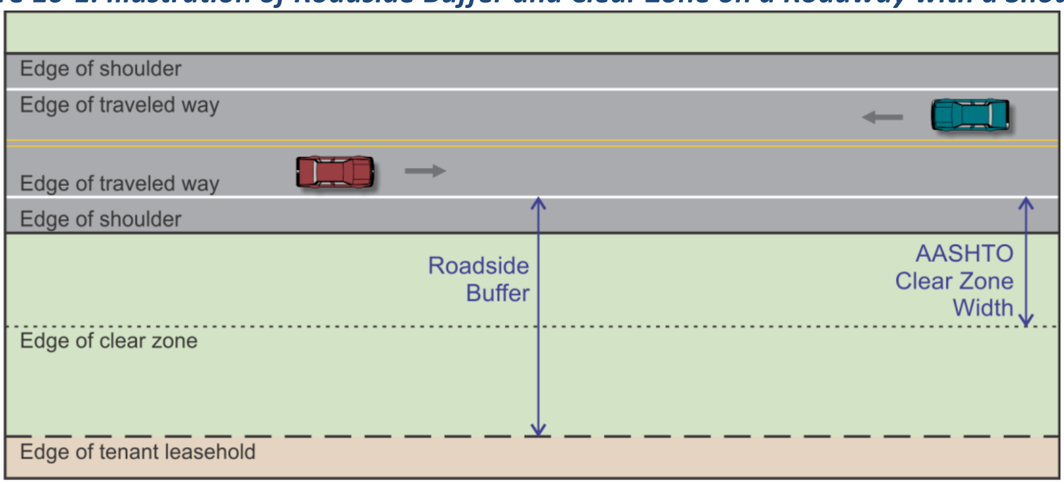
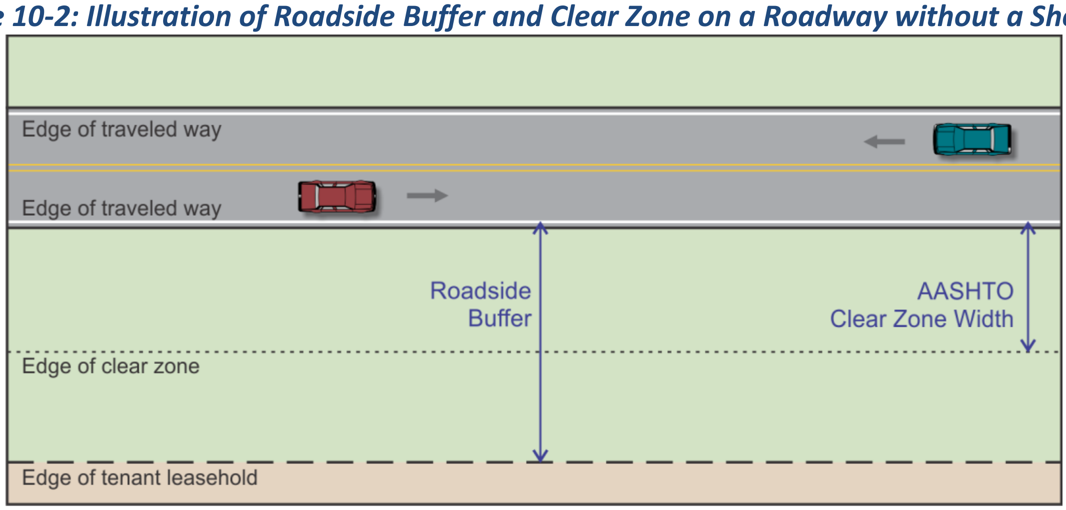


Figure 10-2: Illustration of Roadside Buffer and Clear Zone on a Roadway without a Shoulder

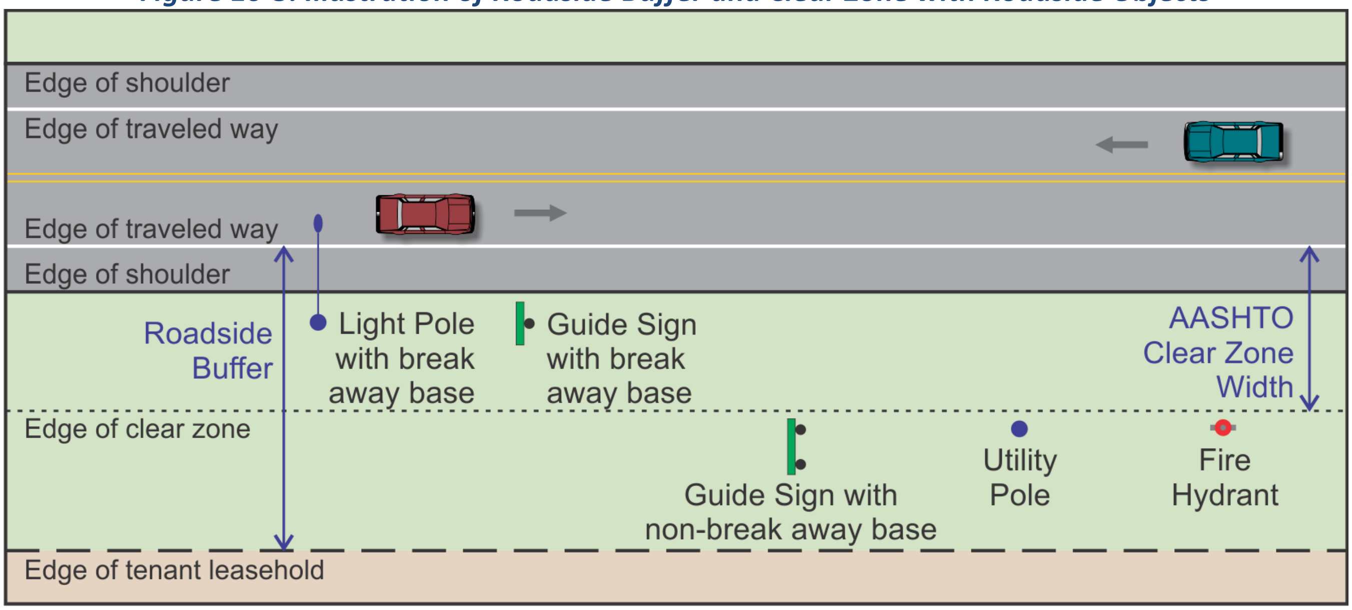


Also, as can be seen in *Figure 10-1* and *Figure 10-2*, the roadside buffer is distinct from the roadside "clear zone" which is defined in the AASHTO *Roadside Design Guide* and may consist of a shoulder, a recoverable slope, and/or a clear run-out area for vehicles departing the roadway. The Port Authority requires a roadside buffer to eliminate obstructions within the clear zone width.

According to the American Association of State Highway and Transportation Officials (AASHTO), approximately thirty percent of traffic fatalities – or almost one in every three – are the result of a single vehicle running off the road and crashing, which is why a clear zone – a traversable recovery area for vehicles leaving the roadway – is a significant traffic safety component of the roadside environment. The roadside buffer and clear zone are consistent with AASHTO's concept of a "forgiving roadside."

Typically, roadside objects (i.e., guide signs, light poles, and a fire hydrant) are located within the roadside buffer, as illustrated in *Figure 10-3*. All roadside objects within the roadside buffer that are non-break away should be placed outside the clear zone. To express this another way, all roadside objects located within the clear zone should be designed to break away upon impact by a vehicle.

Figure 10-3: Illustration of Roadside Buffer and Clear Zone with Roadside Objects



In addition to providing physical space along the roadside for the recovery of errant vehicles, the roadside buffer offers a variety of safety and operational benefits. First, the roadside buffer area affords space for roadside guide signs and placement and maintenance of utilities close to the roadway, as shown in *Figure 10-3*. Roadside appurtenances such as signs and street lights must remain near the roadway to serve their intended functions and should be designed to comply with the provisions in the AASHTO *Roadside Design Guide*. The visibility of guide signs is particularly important at Port Authority facilities because drivers who are unfamiliar with the facility rely on guide signs to locate various tenants and navigate into and out of terminals. Therefore, the roadside buffer should be sufficiently wide to accommodate guide signs that are large enough and contain adequate information to direct drivers into, out of, and within the facility. Second, as shown in *Figure 10-4*, the roadside buffer provides unobstructed sight lines necessary for drivers to see oncoming traffic when they are waiting to turn from intersecting roadways and driveways. It also allows space for pedestrian and/or bicycle pathways, including those that are separated by a buffer from moving vehicles or transit facilities (i.e., bus stops and bus pull-outs). The roadside buffer also can be used for snow storage.

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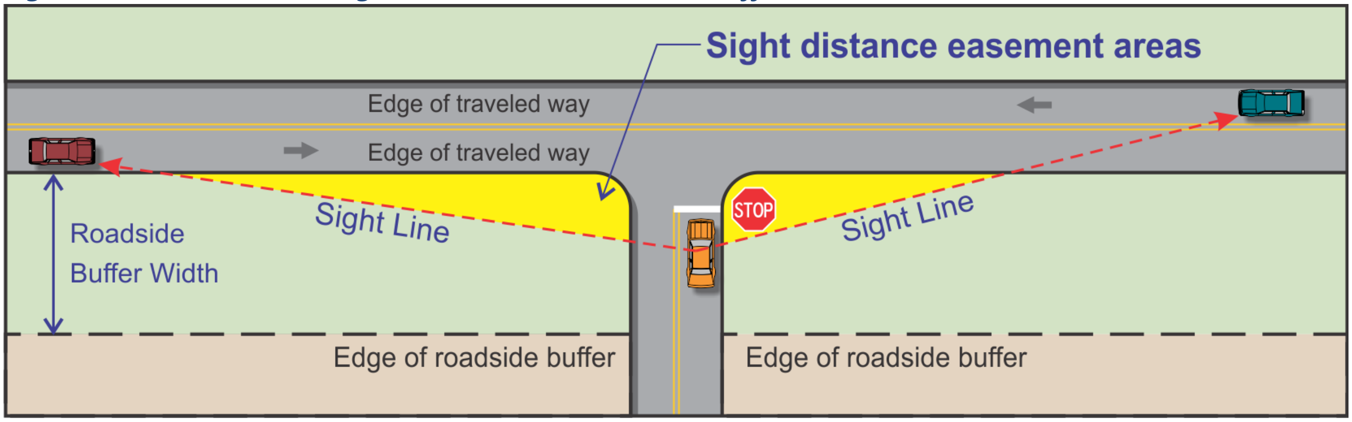
Figure 10-4: Intersection Sight Lines Within Roadside Buffer



10.1.2 Guidance

The following guidance applies to roadside buffers along roadways at Port Authority facilities:

- The Port Authority's guidelines for the width of the roadside buffer are dependent on the roadway's design speed, as shown in *Table 10-1*.

Table 10-1: Desirable Roadside Buffer Widths

Design Speed	Desirable Width
40 mph or less	20 feet
45 and 50 mph	25 feet
55 mph	30 feet

- The roadside buffer area should be a criterion to be considered when determining the location of lease-lines. Tenant lease-lines should not be located within the boundaries of the roadside buffer area. Alternatively, a roadside buffer easement may be defined within the tenant leasehold to accommodate all, or part, of the needed buffer area. This easement restricts the height, size, and placement of objects on the tenant's leasehold within the roadside buffer.
- In some instances – such as along terminal frontage roadways – it may not be feasible to achieve the roadside buffer width shown in *Table 10-1*. Under these circumstances, the design of the roadway should be tailored to conditions at the specific location, considering the roadway's crash history, existing and future vehicle, pedestrian, and bicyclist traffic volumes, and the presence of heavy vehicles. In addition, a design exception is needed (see *Chapter 14*).
- Clear zone widths should be determined using the procedures in the AASHTO *Roadside Design Guide*.[39]
- Fixed (i.e., non-break away) objects on the roadside should be located as far from active travel lanes as practical and should either be designed to be break away or shielded from vehicular impact (to be determined on a project-by-project basis). Fixed objects along the roadside should be located outside the clear zone and may be located within the roadside buffer. Roadside objects that are designed to break

[39] Methodologies to determine clear zone width should be based on latest edition of the AASHTO *Roadside Design Guide*.

away upon impact by a vehicle (e.g., light poles, signs, etc.) are not considered fixed objects and may be located within the clear zone and the roadside buffer.

- Above-ground utilities should be considered for underground installation. Where this is not possible and poles are needed, the utility poles should be located on only one side of the roadway and away from active travel lanes and driveways. Consideration should be given to relocating poles to less vulnerable locations (e.g., on the inside of horizontal curves) and sharing poles among various utilities to reduce pole density. These parameters should be determined on a project-by-project basis.

10.1.3 Example Problem

Given: A Port Authority roadway with a speed of 45 mph.

Problem: Determine the desirable distance that a tenant's fence (i.e., lease line) should be set back from the edge of the traveled way, based on the Port Authority's roadside buffer guidelines.

Solution: Consult *Table 10-1* and use the given design speed to find the desirable roadside buffer width for the setback related to the tenant's fence and lease-line, as highlighted below.

Design Speed	Desirable Width
40 mph or less	20 feet
45 and 50 mph	**25 feet**
55 mph	30 feet

As shown above, the desirable roadside buffer width is 25 feet. In summary, to accommodate the required roadside buffer, it is desirable to set back the tenant's lease-line and fence 25 feet from the edge of the traveled way. If this distance cannot be achieved, a design exception will be required and the tenant's lease-line and fence should be located as far as practical from the edge of the traveled way.

10.2 Intersection Sight Distance

10.2.1 Overview

The provision of adequate intersection sight distance at all intersections – including driveways – along roadways is a fundamental aspect of traffic operations and safety. Sufficient sight distance is needed at all intersections to allow drivers to perceive the presence of potentially conflicting vehicles, whether they are relying on a traffic-control device to determine right-of-way or, in the absence of such a device, relying on the rules of the road. This perception should occur in sufficient time for drivers to stop or adjust their speed, as appropriate, to avoid colliding in the intersection.

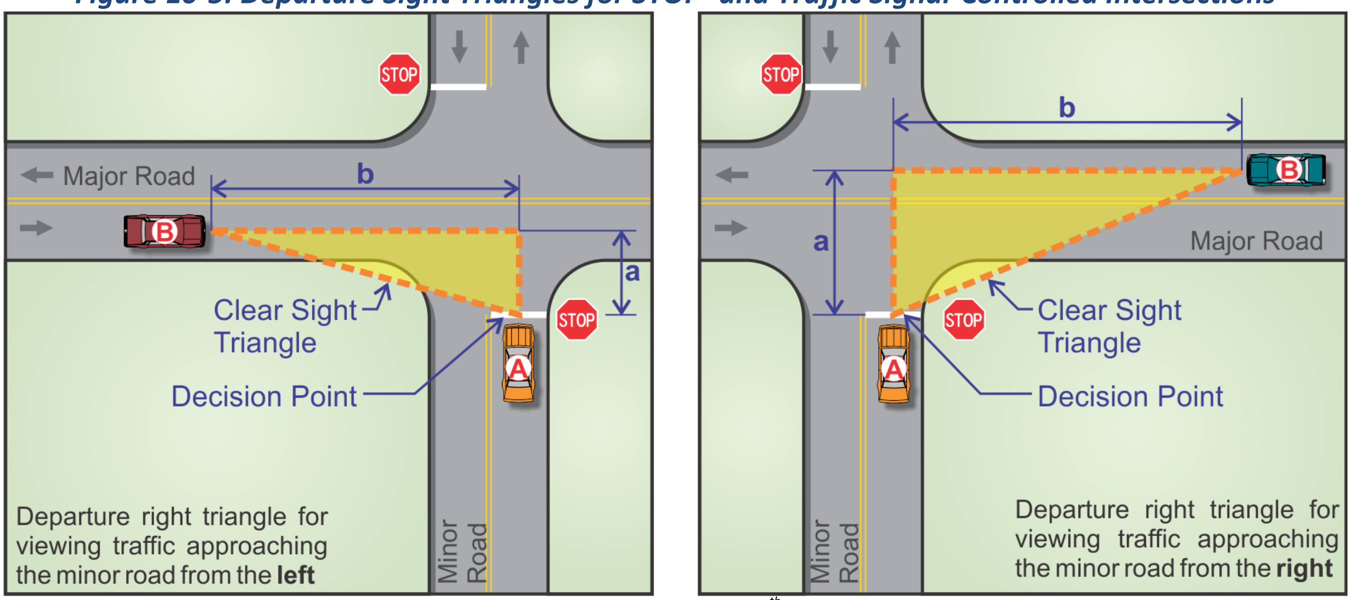
The driver of a vehicle approaching an intersection needs to have not only an unobstructed view of the entire intersection and any traffic control devices, but also sufficient time (and distance) along the intersecting roadway to anticipate and avoid potential collisions. The sight distance needed under various assumptions of physical conditions and driver behavior is directly related to vehicle speeds and to the resultant distances traversed during perception-reaction time and braking.

As such, specified areas along the intersection's approach legs, and across their corners, should be clear of sight obstructions that might block a driver's view of potentially conflicting vehicles. These specified areas are known as "clear sight triangles." The dimensions of the sight triangles depend on the design speeds of the intersecting roadways and the type of traffic control at the intersection. An overview of sight triangles is provided below. AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition*, 2011, pp. 9-28 to 9-54 has been adapted as the basis for the material in this section.

10.2.1.1 Departure Sight Triangles

For intersection approaches controlled by STOP signs or traffic signals, the need for approaching vehicles to stop at the intersection is determined by the traffic control devices and not by the presence or absence of vehicles on the intersecting approaches. Under these conditions, a *departure sight triangle* is needed to provide sufficient sight distance for stopped drivers on a minor roadway approach to view and assess the location and speed of approaching traffic that will conflict with their forward movement from the stop line into the intersection. The drivers must assess the gaps within the conflicting traffic flows and search for a gap of adequate length for the desired movement, which may be a right-turn, a left-turn, or a crossing of the intersection. *Figure 10-5* shows typical departure sight triangles, to the left and to the right, for a vehicle on the minor roadway at the intersection stop line (Driver "A"). Providing clear departure sight triangles also allows the drivers of vehicles on the major roadway (Driver "B") to see any vehicles stopped on the minor roadway approach and be prepared to slow or stop, if necessary.

Figure 10-5: Departure Sight Triangles for STOP- and Traffic Signal-Controlled Intersections



Source: Adapted from AASHTO, *A Policy on Geometric Design of Highways and Streets*, 6th *Edition,* 2011, Exhibit 9-15, p. 9-30.

10.2.1.2 Identification of Obstructions within Sight Triangles

Not only should the profiles of intersecting roadways be designed to provide the recommended sight distances for drivers on the intersection approaches, but also sight triangles should not contain objects that would obstruct the driver's view. Within a sight triangle, any object at a height above the elevation of the adjacent roadways, which could obstruct views, should be removed or lowered. Such objects may include buildings, parked vehicles, highway structures, roadside hardware, hedges, trees, bushes, unmowed grass, walls, fences, and the terrain itself. Even temporary conditions such as piles of plowed snow are sight obstructions if they are located within an intersection's sight triangle.

To determine whether an object constitutes a sight obstruction, the horizontal and vertical alignment of both intersecting roadways, as well as the height and position of the object, should be considered. In making this determination, it should be assumed that the object to be seen is 3.5 feet above the surface of the intersecting road. Where the sight distance value used in design is based on a passenger car as the design vehicle, it should be assumed that the driver's eye is 3.5 feet above the roadway surface. Where the design vehicle is a single-unit or combination truck, it is also appropriate to use the recommended eye height of a truck driver – 7.6 feet above the roadway surface – in checking sight obstructions. However, even in instances where the design vehicle is a truck, adequate sight distance should also be provided for drivers of passenger cars, with the driver's eye assumed to be 3.5 feet above the roadway surface.

10.2.1.3 Calculation of Sight Triangle Dimensions

Because different types of traffic control devices impose different constraints on drivers – and, therefore, result in different driver behaviors – the recommended dimensions for approach and departure sight triangles vary with the type of traffic control devices used at an intersection and the associated traffic movements, as summarized below:

- **Case A:** Intersections with no traffic control
- **Case B:** Intersections with STOP control on the minor road:
    - **Case B1:** Left-turn from the minor road
    - **Case B2:** Right-turn from the minor road
    - **Case B3:** Crossing maneuver from the minor road
- **Case C:** Intersections with yield control on the minor road
    - **Case C1:** Crossing maneuver from the minor road
    - **Case C2:** Left-turn or right-turn from the minor road
- **Case D:** Intersections with traffic signal control
- **Case E:** Intersections with all-way stop control
- **Case F:** Left-turns from the major road

The detailed calculation procedures for determining the sight triangle dimensions for all cases listed above are found in AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011* (pp. 9-28 to 9-54), or superseding editions.

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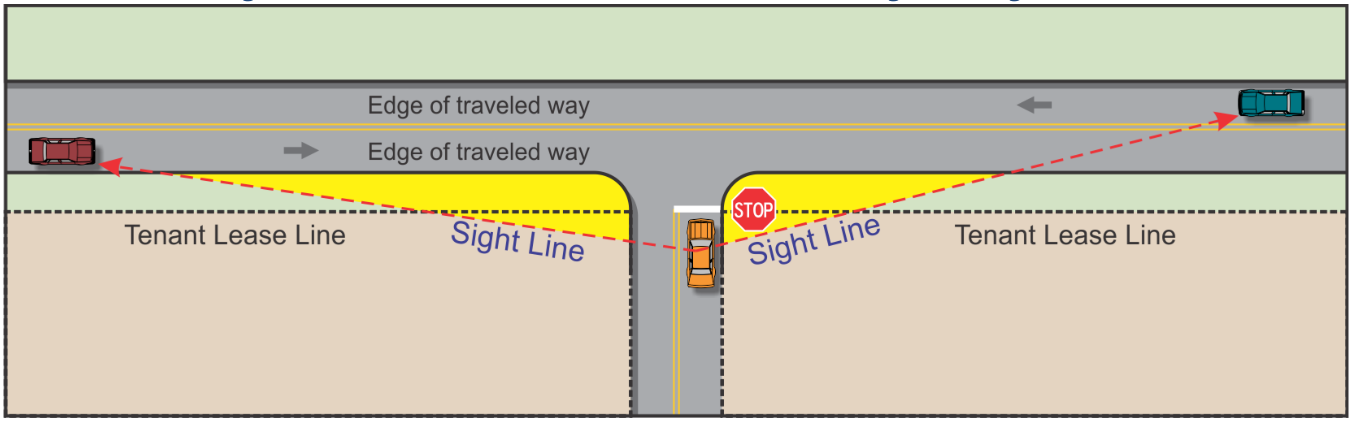
10.2.1.4 Sight Triangle Easements

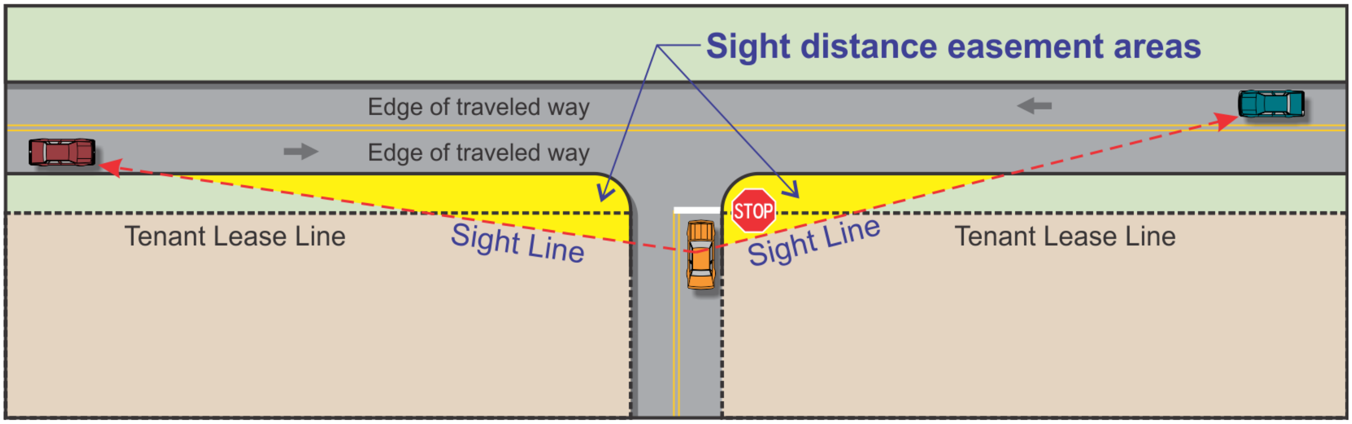
To provide unobstructed sight lines, tenant lease-lines should be set back outside the sight triangle areas, as shown in *Figure 10-6*.

Figure 10-6: Tenant Lease-Lines Located Outside Sight Triangle Areas



Alternatively, a sight distance easement may be defined within the tenant leasehold to accommodate the needed sight lines, as shown in *Figure 10-7*. This easement restricts the height, size, and placement of objects on the tenant's leasehold within the area of the sight distance triangles including fences, gates, signs, and landscaping. Tenants and other stakeholders should ensure that adequate sight lines are preserved.[40]

Figure 10-7: Intersection Sight Lines Extending Beyond Tenant Lease-Lines



10.2.2 Intersection Sight Distance Guidelines

The following guidance applies to intersection sight distance for all roadways at Port Authority facilities:

- The sight distance guidelines described in this chapter should apply to all types of intersections (including driveways) along Port Authority roadways, regardless of the vehicle types involved and the function of the roadway. This provision should also apply to crosswalks and Restricted Vehicle Service Roads.
- The vertical and horizontal profiles of intersecting roadways (including driveways) should be designed to provide adequate sight distances for drivers on the intersection approaches.

[40] For more guidance, refer to *Municipal Regulation of Traffic View Obstructions*, by J. H. Vogel and E. H. Campbell, February 1953.

- Within a sight triangle, any object at a height above the elevation of the adjacent roadways that would obstruct the driver's view should be removed or lowered. Such objects may include buildings, parked vehicles, highway structures, roadside hardware, hedges, trees, bushes, unmowed grass, walls, fences, and the terrain itself.

- The decision of which case to use for the intersection sight distance calculations should be based on the decisions made at the team conceptual planning meeting.

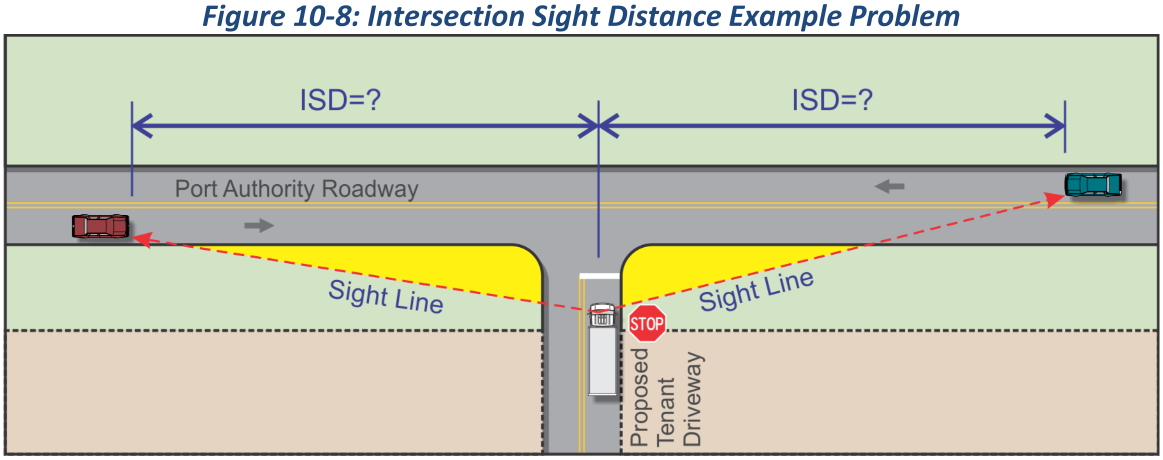
- Intersection sight distance triangles should be a criterion to be considered when determining the location of lease-lines. These lines should be recorded in appropriate legal documents such as deeds and leasehold agreements.

- In order to provide adequate sight triangles, *tenant lease-lines should be set back from the edge of the traveled* way and should not be located within the sight triangles. Alternatively, a sight distance easement may be defined within the tenant leasehold to provide for adequate sight distance. This easement restricts the height, size, and placement of objects on the tenant's leasehold within the sight triangles, such that drivers stopped at the driveway can view vehicles approaching the driveway along the intersecting roadway without their sight lines being obstructed by trees, bushes, terrain, signing, and other obstacles.

10.2.3 Example Problem

Given: A new tenant driveway is proposed to be located along a two-way Port Authority roadway that has one lane in each direction (see *Figure 10-8*). The driveway will be stop-controlled at its intersection with the Port Authority roadway. The design speed on the Port Authority roadway is 45 mph (prevailing travel speeds are also observed to be 45 mph). The approach grade of the driveway is two percent.

Figure 10-8: Intersection Sight Distance Example Problem



Problem: Calculate and compare the Intersection Sight Distance (ISD) needed at the tenant's proposed driveway based on both a single-unit truck (SU) as the design vehicle and a combination tractor-trailer as the design vehicle.

Solution: The procedures on pages 9-28 to 9-54 of the 2011 AASHTO "Green Book" should be used for calculating the needed intersection sight distance. The situation described above – an intersection with STOP control on the minor roadway – is "Case B" in AASHTO.

Equation 9-1 on page 9-37 of the "Green Book" provides the following formula for calculation of Intersection Sight Distance (ISD) for left-turns from the minor road, in US customary units:

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$$ISD = 1.47 \times V_{major} \times t_g$$

Where: **1.47 = a constant (feet-hour/mile-seconds)**

V_{major} = design speed of major roadway (mph)

t_g = time gap for minor roadway vehicle to enter the major road (seconds)

Table 9-5 on page 9-37 of the 2011 AASHTO "Green Book" provides the values of the time gap (t_g) for various vehicle types. For a SU truck, t_g = 9.5 seconds. For a combination truck, t_g = 11.5 seconds. Therefore:

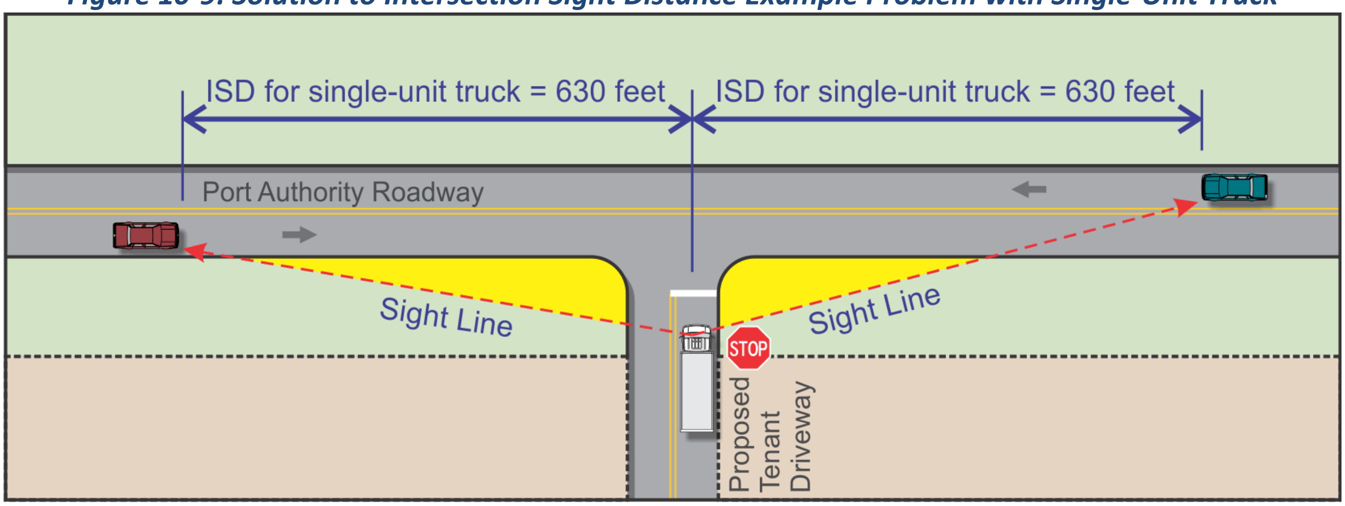
ISD for a SU truck = 1.47 feet-hour/mile-seconds × 45 miles/hour × 9.5 seconds = 628.43 feet

ISD for a combination truck = 1.47 feet-hour/mile-seconds × 45 miles/hour × 11.5 seconds = 760.73 feet

As shown in *Figure 10-9,* the calculated intersection sight distance for the SU truck is 628.43 feet, or 630 feet rounded for design purposes. As shown in *Figure 10-10*, the calculated intersection sight distance for the combination truck is 760.73 feet, or 765 feet, rounded for design purposes. No grade adjustment[41] is needed because the approach grade of the driveway is less than four percent.

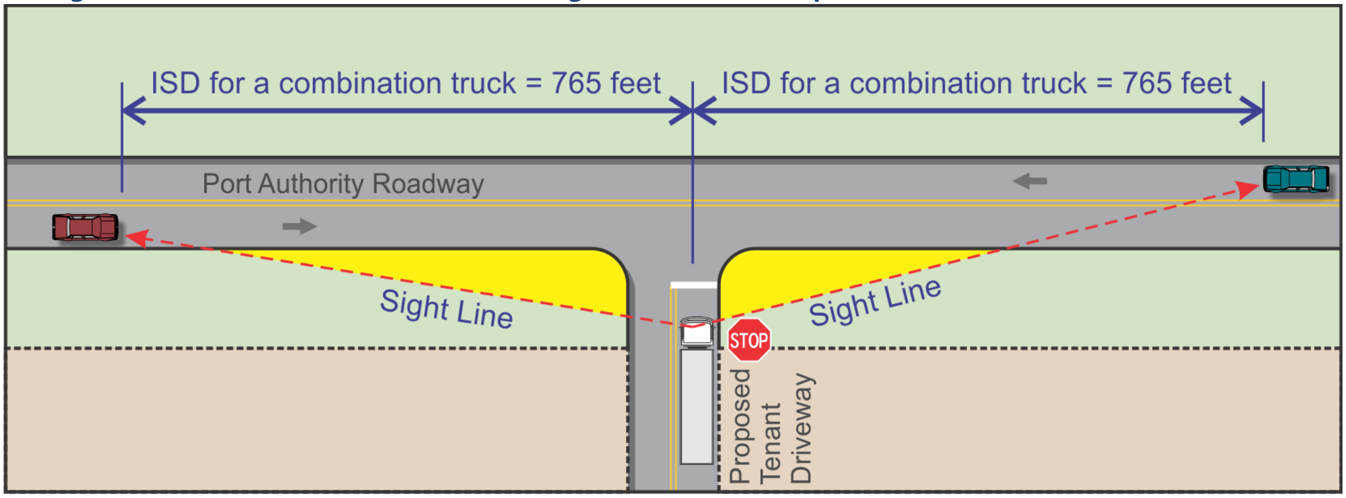
Additionally, as this is a T-intersection, there is no crossing maneuver from the minor road, so Case B3 (crossing maneuver from the minor road) does not apply. Also, it should be noted that Case B2 (right-turn from the minor road) results in an intersection sight distance that is shorter than the distance calculated above (for left-turns from the minor road) and, therefore, is not used for design purposes.

Figure 10-9: Solution to Intersection Sight Distance Example Problem with Single-Unit Truck



[41] Table 9-4 on page 9-35 of the 2011 AASHTO "Green Book" provides grade adjustment factors.

Figure 10-10: Solution to Intersection Sight Distance Example Problem with Combination Truck



Following the procedures in the AASHTO "Green Book," the dimensions of the sight triangles to the right and left of the tenant's proposed driveway can now be determined based on the calculated intersection sight distance in both directions for a SU truck or a combination truck (630 feet and 765 feet, respectively) and the distance between the driver's eye and the edge of the traveled way (14.5 feet as per the AASHTO "Green Book"). Objects located, or planned to be located, within these sight triangles should be limited in size, relocated, or eliminated entirely so as not to obstruct intersection sight lines.

Furthermore, when determining the acceptable sizes and locations of objects within the sight triangle areas, the vertical aspects of the needed sight lines should be taken into account, in addition to the horizontal aspects. This involves consideration of the vertical profiles for both the roadway and the driveway. It also involves using designated values for the height of the driver's eye and the height of the oncoming vehicle (which are 3.5 feet for passenger cars, as per the AASHTO "Green Book").

Because the design vehicle is a truck in the example problem above, AASHTO recommends using a driver's eye height of 7.6 feet (higher than the passenger car eye height of 3.5 feet). However, it is important to note that the use of this higher eye height may not adequately preserve sight lines for drivers of passenger cars, who are also likely to use the driveway. Therefore, both values for eye height – 3.5 feet for a passenger car and 7.6 feet for a truck – should be checked as part of the design process to ensure that adequate sight lines for all vehicles are accommodated at the driveway.

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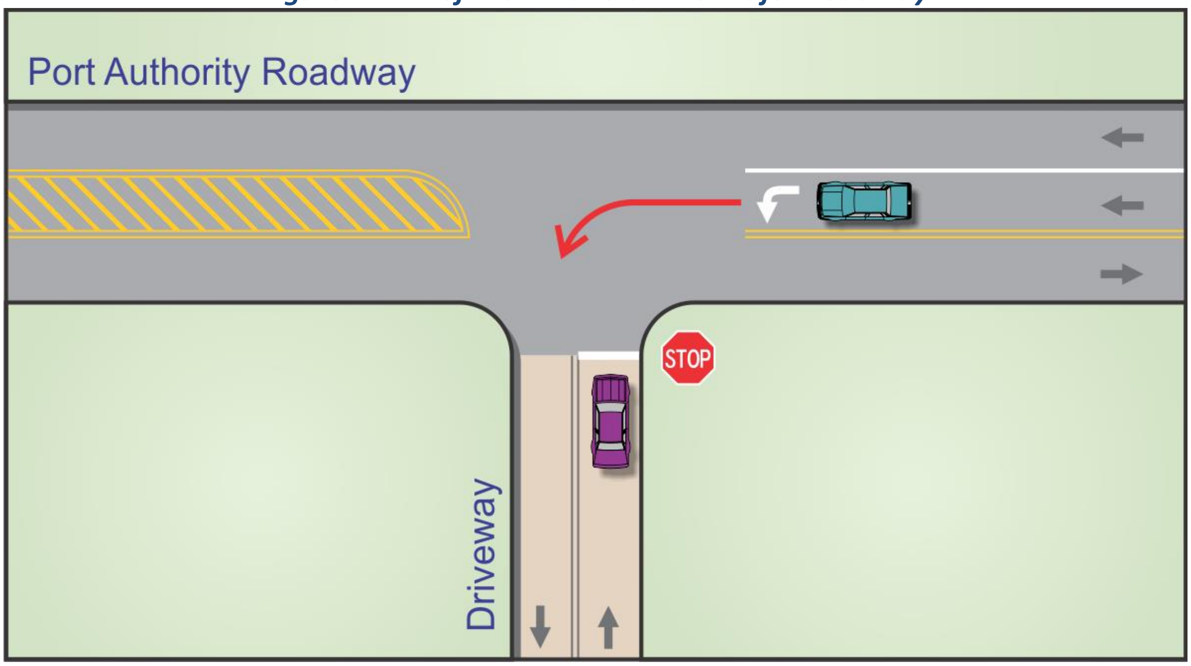
CHAPTER 11: LEFT-TURN LANES

11.1 Overview

Left-turn movements, especially those that are made from lanes that are shared with through traffic, may cause delays. In addition, research has demonstrated that ingress left-turn movements (left-turns from the roadway into a driveway) are associated with approximately 47 percent of all crashes at driveways. This chapter focuses on the provision of left-turn lanes on roadways at Port Authority facilities, as shown in *Figure 11-1*. Guidelines for left-turn lanes located on driveways are provided in *Chapter 9*.

Figure 11-1: Left-Turn Lane on the Major Roadway



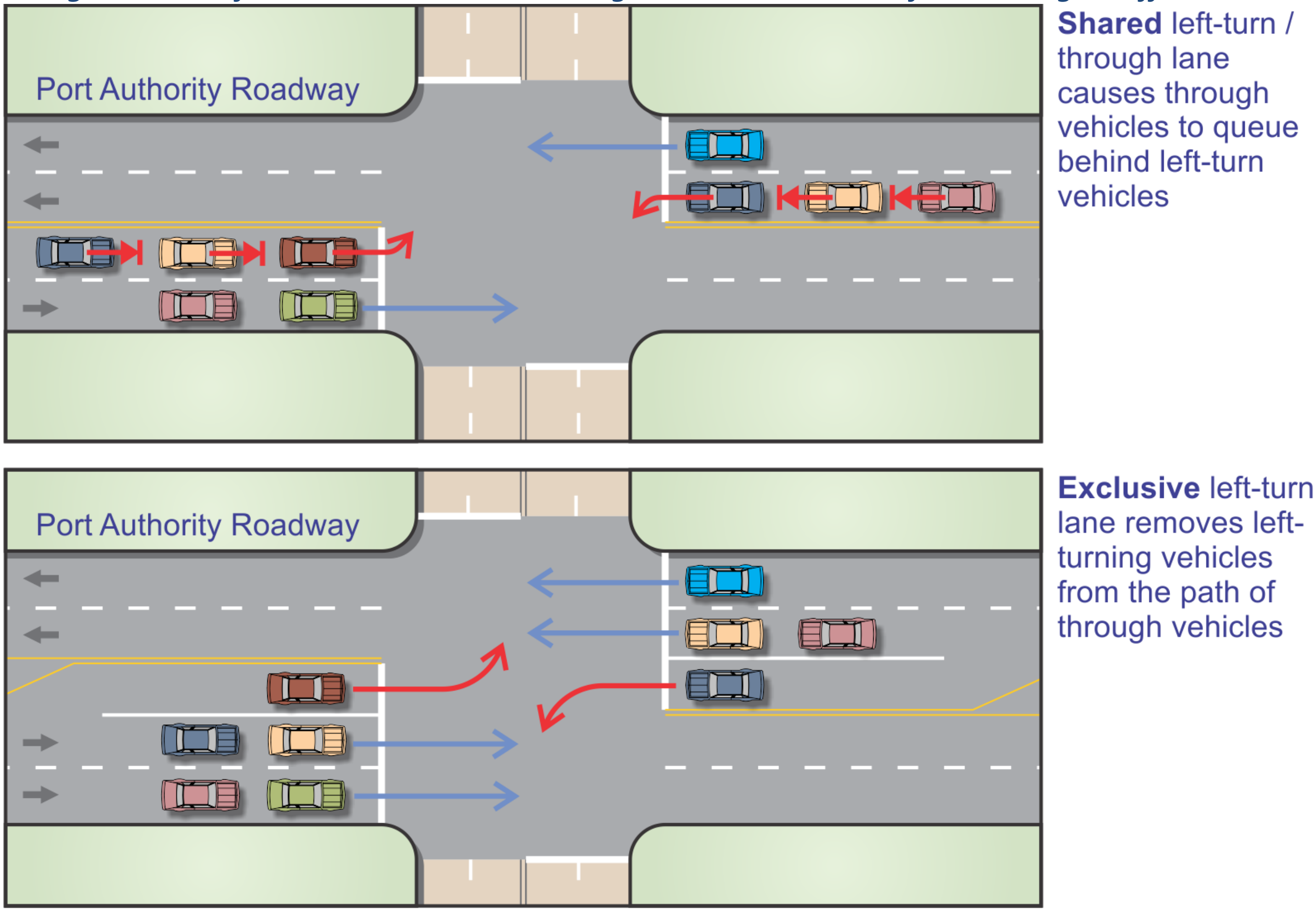
Auxiliary lanes include both left-turn lanes and right-turn lanes. They provide a refuge for left-turning and right-turning vehicles by removing those vehicles from the through traffic lane(s). As such, they are an effective means of eliminating the speed differential that exists between a turning vehicle and the through vehicles that follow when left-turns and right-turns are made from a shared through/turn lane. The addition of exclusive left-turn lanes has been shown to provide a variety of traffic safety and operational benefits including the following:

- Reducing the number of conflicts and crashes (particularly rear-end, angle, and sideswipe crashes)
- Physically separating left-turning traffic and queues from through traffic (see *Figure 11-2*)
- Decreasing vehicular delay and increasing intersection capacity
- Providing an area for left-turning vehicles to decelerate outside of the through travel lane
- Providing greater operational flexibility (e.g., additional traffic signal phasing opportunities)

In addition, research[42] has shown that left-turn lanes are likely to be warranted at most unsignalized intersections (except at those with very low volumes) based primarily on the cost savings attributable to an expected decrease in the number of crashes as a result of the left-turn lane installation.

[42] NCHRP Report 745: *Left-Turn Accommodations at Unsignalized Intersections*, 2013.

Figure 11-2: Left-Turn Lanes Remove Turning Vehicles and Queues from Through Traffic Stream



Source: FHWA, *Signalized Intersections: An Informational Guide*, August 2004, Figure 13, p. 41.

Despite the many potential safety and operational benefits associated with providing left-turn lanes, the decision to install a left-turn lane should also consider the potential drawbacks of doing so. These include the need for additional right-of-way along the roadway to accommodate the added width and length of the left-turn lane, as well as longer crossing times for pedestrians at the subject intersection, resulting in increased pedestrian exposure to moving vehicular traffic. Installing a left-turn lane dedicates more of the available roadway cross-section to accommodating motor vehicle traffic, rather than providing accommodations for pedestrians, bicycles, and transit facilities (i.e., bus stops and bus pull-outs). See *Chapter 4* for additional guidance regarding "complete streets."

11.2 General Considerations for Left-Turn Lane Installation

Whether to install a left-turn lane should be determined on a site-specific, case-by-case basis considering a range of factors within the overall context of the particular project. For example, the need for a left-turn lane should be weighed against the need for other cross-sectional features such as medians, sidewalks, bike lanes, roadside clear zones, through lanes, and right-turn lanes. There is no "one size fits all" solution. Specific factors to consider when making the decision to install a left-turn lane should include:

- Safety (potential conflicts and crash history, including crash types, severity, and causes)
- Type of project (i.e., redevelopment program, TAA, etc.) and its context within the Port Authority facility
- Existing cross-section of the roadway and the available right-of-way

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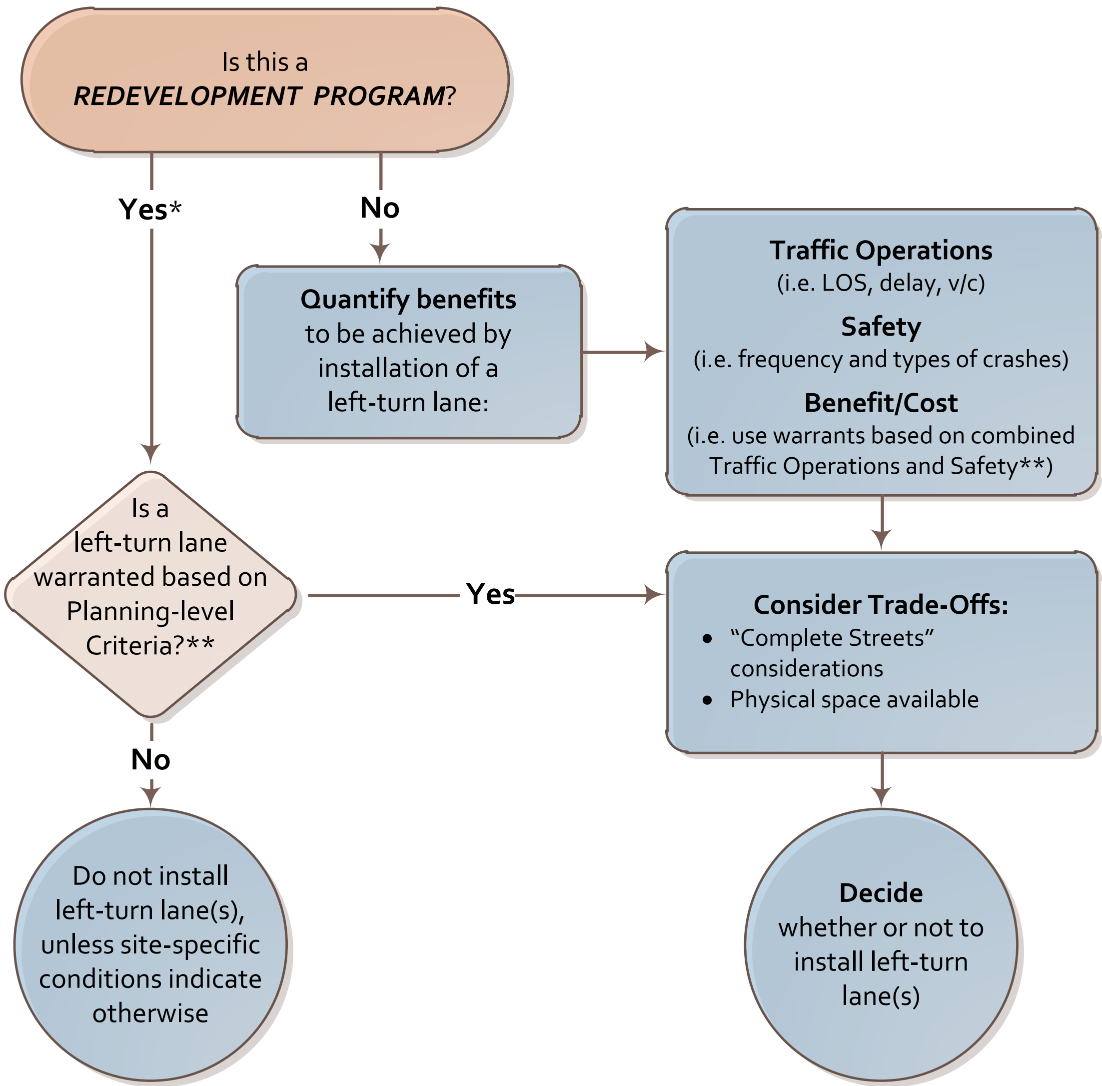
- Roadway's access classification and function
- Prevailing vehicle speeds
- Traffic control devices and intersection operations
- Left-turn traffic volume and other movement volumes
- Roadway alignments

Below, in *Figure 11-3,* is a decision tree that provides a basic framework to assist in determining whether to install a left-turn lane. Given the unique characteristics of particular types of Port Authority projects and the associated traffic operations, safety, and benefit/cost considerations regarding a left-turn lane installation, *Figure 11-3* is simply a general guidance framework and not prescriptive guidelines, which are presented below in *Section 11.3*, with respect to the installation of left-turn lanes.

Figure 11-3: Left-Turn Lane Installation Guidance Framework



* Supplemental guidance for redeveloping areas, such as a formal redevelopment program, can be found in:
1) *Traffic Circulation Planning for Communities*, by H. Marks, 1974.
2) *Transportation and Land Development, 2nd Edition*, by V. Stover and F. Koepke, 2002.
** See Table 11-1 for warrant criteria.

11.3 Guidelines

The following Port Authority access management guidelines relative to left-turn lanes should be applied in conjunction with the decision tree shown above in *Figure 11-3*. The guidelines are presented in two sub-sections: 1) installation warrants and 2) design guidelines.

11.3.1 Left-Turn Lane Installation Warrants

The following are warrant guidelines that should be considered when determining whether to install a left-turn lane:

- **Planning-Level Criteria:** As described previously in this chapter, there are many traffic safety and operations benefits to installing left-turn lanes. Often, one of the primary barriers to installation of a new left-turn lane is the availability of sufficient right-of-way to physically accommodate the lane. Port Authority redevelopment programs provide unique opportunities to install left-turn lanes because of the potential for significant changes to be made to tenant lease lines and available rights-of-way. Therefore, left-turn lanes should be considered at all intersections and driveways included as part of Port Authority redevelopment programs, using the left-turn lane warrant volumes shown in *Table 11-1* for planning purposes. These warrants are based on a benefit/cost approach that compares the traffic safety and operational benefits to the costs associated with the left-turn lane installation.

Table 11-1: Left-Turn Lane Warrants

Peak Hour Left-Turn Lane Volume (vehicles/hour)	Peak Hour Major Street Volume (vehicles/hour/approach)	
	Three-Leg Intersection	Four-Leg Intersection
5	450	50
10	300	50
15	250	50
20	200	50
25	200	50
30	150	50
35	150	50
40	150	50
45	150	less than 50
50 or more	100	less than 50

Source: *NCHRP Report 745: Left-Turn Accommodations at Unsignalized Intersections*, 2013.

Excluding redevelopment programs, most Port Authority projects – such as Tenant Alteration Application and roadway improvement projects – are considered retrofit projects. Under these circumstances, the installation of left-turn lanes is often limited by right-of-way constraints, existing building locations, and other features of the built and natural environment. Therefore, under retrofit situations, left-turn lanes should be considered for installation where opportunities arise considering traffic safety criteria and traffic operations criteria, as well as the benefit/cost warrants shown in *Table 11-1*. The traffic safety and operational criteria are described below.

- **Safety Performance Criteria:** Left-turn lanes should be considered where an engineering study, which includes analysis of the crash history on the subject approach, indicates a high number or disproportionate

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percentage of crash types correctable by installation of a left-turn lane.

- **Operational Performance Criteria:** Left-turn lanes should be considered where a traffic operations analysis shows they are needed to provide an acceptable operational level at the intersection based on:
    - vehicular delay and level-of-service criteria and/or
    - volume-to-capacity criteria

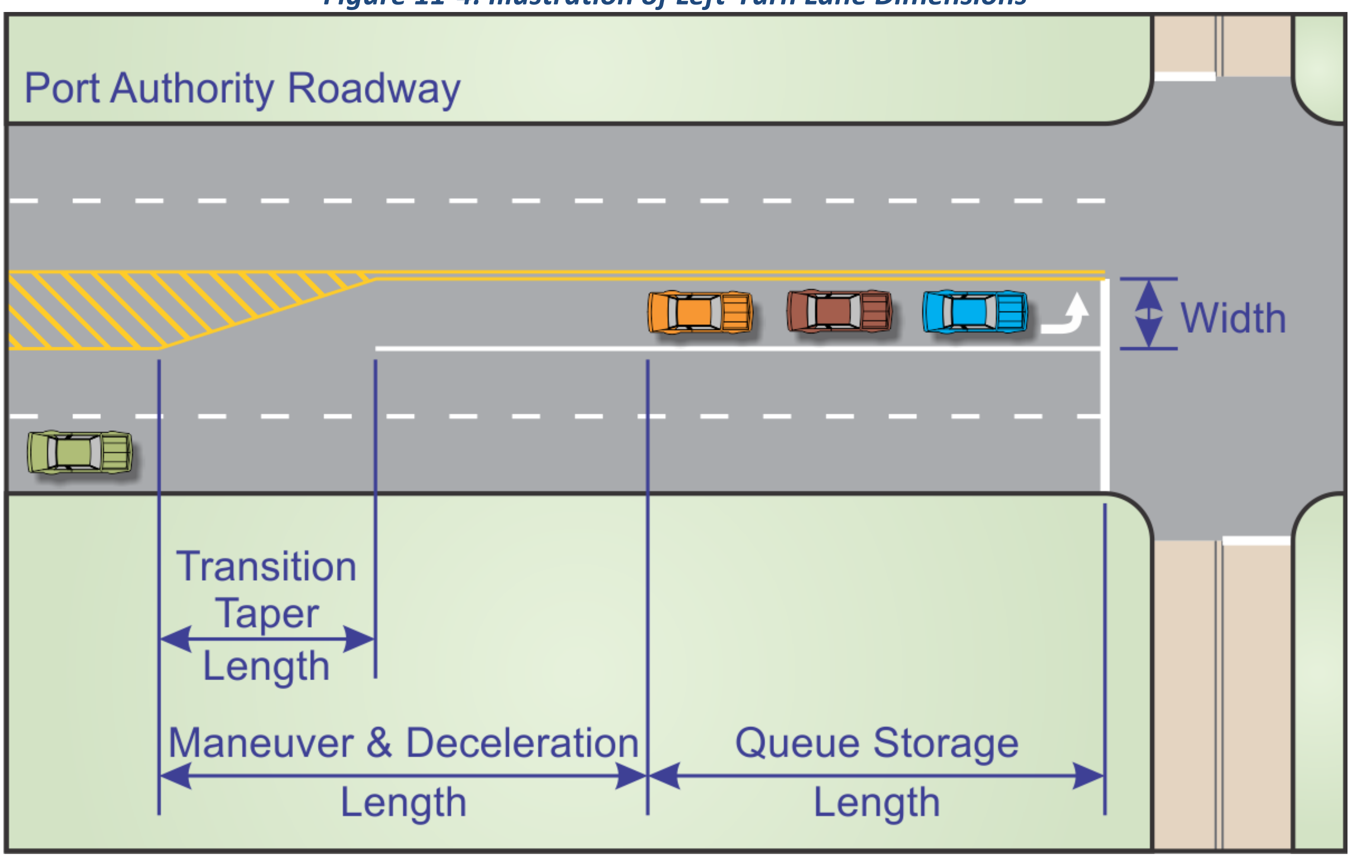
  Left-turn lanes also should be considered where protected left-turn signal phasing is warranted.

  As part of the operations analysis, pedestrian operations should be analyzed when deciding to install a left-turn lane. The projected operational impacts on pedestrians should be considered in the decision to install a left-turn lane.

11.3.2 Left-Turn Lane Design Guidelines

Once a decision to install a left-turn lane has been made, a variety of other decisions should be made relative to the design of the left-turn lane, including its width, queue storage length, and taper. The following design guidance applies to left-turn lanes on all Port Authority roadways (see *Figure 11-4* for an illustration of the left-turn lane dimensions):

Figure 11-4: Illustration of Left-Turn Lane Dimensions



- The desirable width of a left-turn lane should be 12 feet.
- The total length of the left-turn lane should be designed to include: 1) the transition taper length, 2) vehicle maneuver and deceleration length, and 3) vehicle queue storage length. These distances shall be

determined as follows:

- The transition taper should be 75 feet on undivided roadways. On divided roadways, the transition taper should follow the design guidance in AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011* (pp. 9-127 to 9-130), or superseding edition.

- The desirable maneuver and deceleration length are given in *Table 11-2*. The desirable maneuver and deceleration length is based on the posted speed and ranges from 90 feet (at a posted speed of 20 mph) to 425 feet (at a posted speed of 50 mph).

Table 11-2: Desirable Maneuver and Deceleration Length

Posted Speed (mph)[1]	Maneuver and Deceleration Length (feet)
20	90
25	110
30	160
35	215
40	275
45	345
50	425

Source: Adapted from Stover, V.G. and F.J. Koepke, *Transportation and Land Development, 2nd Edition*, 2002, Table 5-13, page 5-43.

1: The 85th percentile speed may be used in place of the posted speed if an engineering study that supports the use of the 85th percentile speed over the posted speed is completed and approved by Port Authority Traffic Engineering.

- The desirable queue storage length should equal the 95th percentile queue length. The queue storage length should be adjusted to account for the lengths of the various vehicles in the traffic stream (i.e., passenger cars, single-unit trucks, tractor-trailers, etc.).

- Dual left-turn lanes should be considered when the volume of left-turns exceeds 300 vehicles per hour.

- Sight distance restrictions for left-turn movements at intersections should be avoided. This may be accomplished by implementing a positive offset, which is a lateral shift in the left-turn lane alignment to improve the ability of left-turning motorists to see oncoming traffic**.** A positive offset should be considered where there exists:

  - a center (median) lane wider than 12 feet
  - sufficient right-of-way or
  - a crash history reflecting a sight distance issue for left-turn movements

With a positive offset, the sight lines between a left-turning driver and oncoming through traffic are not blocked by left-turning vehicles on the opposing approach. The offset may be accomplished using either pavement markings or a raised channelization island; it is measured between the left edge of the left-turn lane and the right edge of the opposing left-turn lane.

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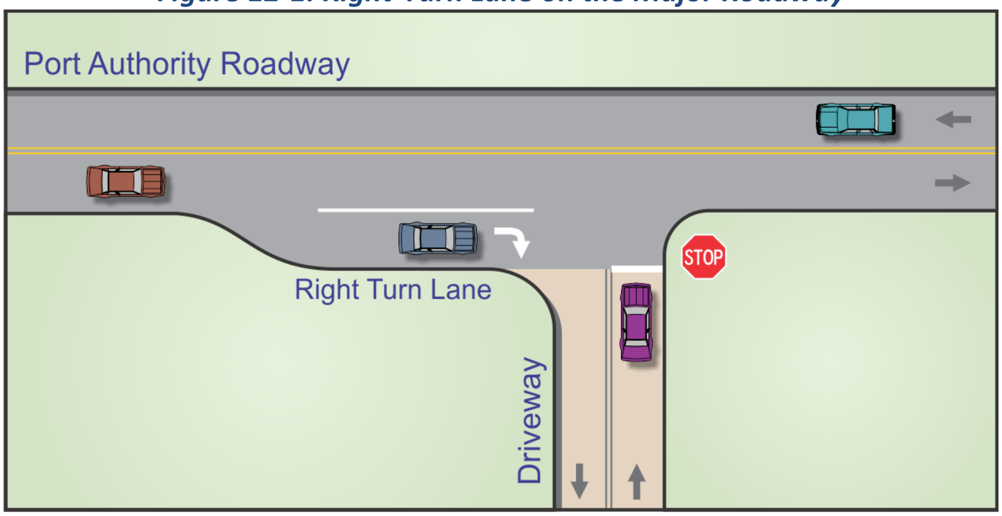
CHAPTER 12: RIGHT-TURN LANES

12.1 Overview

Like left-turn movements, right-turn movements − especially those that are made from lanes that are shared with through traffic − may cause delays. In addition, research has demonstrated that ingress right-turn movements (right-turns from the roadway into a driveway) are associated with approximately 16 percent of all crashes at driveways. Furthermore, the Federal Highway Administration estimates that the addition of an exclusive right-turn lane on a multi-lane approach can reduce fatal/injury collisions by 40 percent and property damage only (PDO) crashes by 10 percent. This chapter focuses on the provision of right-turn lanes on roadways at Port Authority facilities, as shown in *Figure 12-1*. Guidelines for right-turn lanes located on driveways are provided in *Chapter 9*.

Figure 12-1: Right-Turn Lane on the Major Roadway

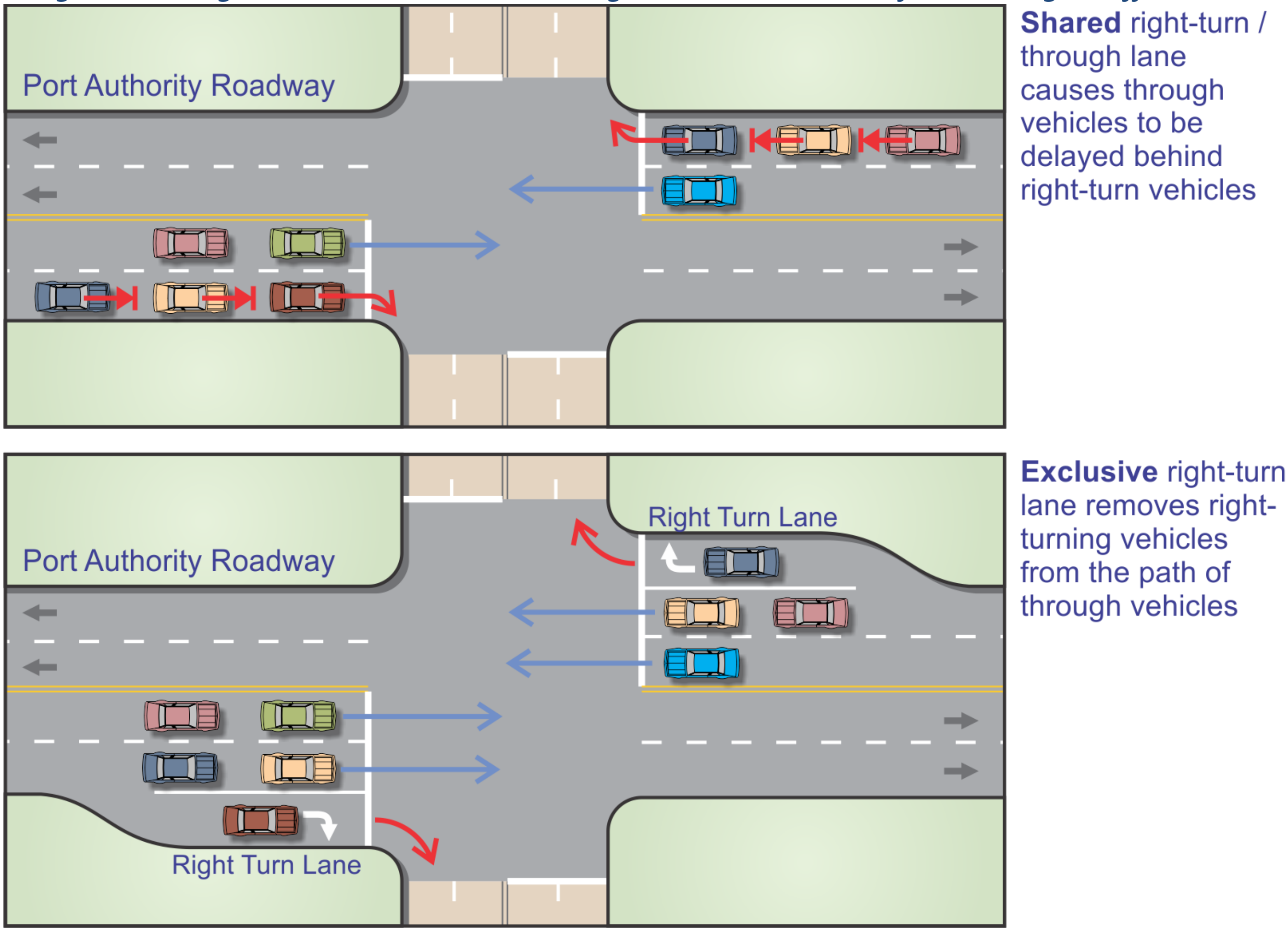


Auxiliary lanes include both left-turn lanes and right-turn lanes. They provide a refuge for left-turning and right-turning vehicles by removing those vehicles from the through traffic lane(s). As such, they are an effective means of eliminating the speed differential that exists between a turning vehicle and the through vehicles that follow when left-turns and right-turns are made from a shared through/turn lane. The addition of exclusive right-turn lanes has been shown to provide a variety of traffic safety and operational benefits including the following:

- Reducing the number of conflicts and crashes (particularly rear-end and sideswipe crashes)
- Physically separating right-turning traffic and queues from through traffic (see *Figure 12-2*)
- Decreasing vehicular delay and increasing intersection capacity
- Providing an area for right-turning vehicles to decelerate outside of the through travel lane
- Providing greater operational flexibility (e.g., right-turn overlap signal phasing, operating concurrently with protected left-turn phasing on the intersecting cross-street)

Despite the many potential safety and operational benefits associated with providing right-turn lanes, the decision to install a right-turn lane should also consider the potential drawbacks of doing so. These include the need for additional right-of-way along the roadway to accommodate the added width and length of the right-turn lane, as well as longer crossing times for pedestrians at the subject intersection, resulting in increased pedestrian exposure to moving vehicular traffic. Installing a right-turn lane dedicates more of the available roadway cross-section to accommodating motor vehicle traffic, rather than providing accommodations for pedestrians, bicycles, and transit facilities (i.e., bus stops and bus pull-outs). See *Chapter 4* for additional guidance regarding "complete streets."

Figure 12-2: Right-Turn Lanes Remove Turning Vehicles and Queues from Through Traffic Stream



12.2 General Considerations for Right-Turn Lane Installation

Whether to install a right-turn lane should be determined on a site-specific, case-by-case basis considering a range of factors within the overall context of the particular project. For example, the need for a right-turn lane should be weighed against the need for other cross-sectional features such as medians, sidewalks, bike lanes, roadside clear zones, through lanes, and left-turn lanes. There is no "one size fits all" solution. Specific factors to consider when making the decision to install a right-turn lane should include:

- Safety (potential conflicts and crash history, including crash types, severity, and causes)
- Type of project (i.e., redevelopment program, TAA, etc.) and its context within the Port Authority facility
- Existing cross-section of the roadway and the available right-of-way
- Roadway's access classification and function
- Prevailing vehicle speeds
- Traffic control devices and intersection operations
- Right-turn traffic volume and other movement volumes
- Roadway alignments

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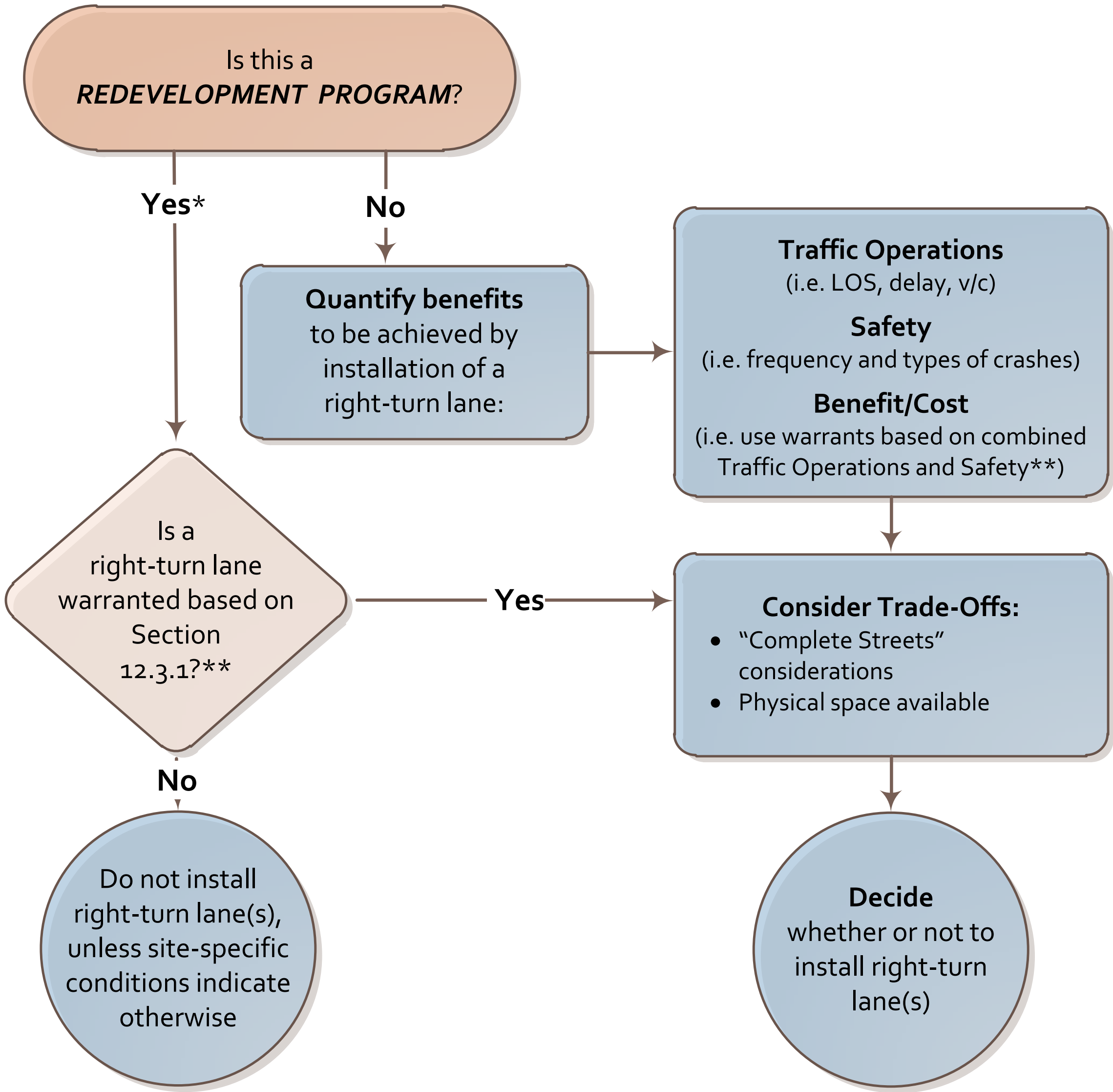
Below, in *Figure 12-3,* is a decision tree that provides a basic framework to assist in determining whether to install a right-turn lane. Given the unique characteristics of particular types of Port Authority projects and the associated traffic operations, safety, and benefit/cost considerations regarding a right-turn lane installation, *Figure 12-3* is simply a general guidance framework and not prescriptive guidelines, which are presented below in *Section 12.3*, with respect to the installation of right-turn lanes.

Figure 12-3: Right-Turn Lane Installation Guidance Framework



* Supplemental guidance for redeveloping areas, such as a formal redevelopment program, can be found in:
1) *Traffic Circulation Planning for Communities*, by H. Marks, 1974.
2) *Transportation and Land Development, 2nd Edition*, by V. Stover and F. Koepke, 2002.

** See Figures 12-4 through 12-7 for warrant criteria.

12.3 Guidelines

The following Port Authority access management guidelines relative to right-turn lanes should be applied in conjunction with the decision tree shown above in *Figure 12-3*. The guidelines are presented in two sub-sections: 1) installation warrants and 2) design guidelines.

12.3.1 Right-Turn Lane Installation Warrants

The following are warrant guidelines that should be considered when determining whether to install a right-turn lane:

- **Planning-Level Criteria:** As described previously in this chapter, there are many traffic safety and operations benefits to installing right-turn lanes. Often, one of the primary barriers to installation of a new right-turn lane is the availability of sufficient right-of-way to physically accommodate the lane. Port Authority redevelopment programs provide unique opportunities to install right-turn lanes because of the potential for significant changes to be made to tenant lease lines and available rights-of-way. Therefore, right-turn lanes should be considered at all intersections and driveways included as part of Port Authority redevelopment programs, using the right-turn lane warrant curves shown in *Figures 12-4* through *12-7* for planning purposes. These warrants are based on a benefit/cost approach that compares the traffic safety and operational benefits to the costs associated with the turn lane installation.

  Excluding redevelopment programs, most Port Authority projects – such as Tenant Alteration Application and roadway improvement projects – are considered retrofit projects. Under these circumstances, the installation of right-turn lanes is often limited by right-of-way constraints, existing building locations, and other features of the built and natural environment. Therefore, under retrofit situations, right-turn lanes should be considered for installation where opportunities arise considering traffic safety criteria and traffic operations criteria, as well as the benefit/cost warrants shown in *Figures 12-4* through *12-7*. The traffic safety and operational criteria are described below.

- **Safety Performance Criteria:** Right-turn lanes should be considered where an engineering study, which includes analysis of the crash history on the subject approach, indicates a high number or disproportionate percentage of crash types correctable by installation of a right-turn lane.

- **Operational Performance Criteria:** Right-turn lanes should be considered where a traffic operations analysis shows they are needed to provide an acceptable operational level at the intersection based on:

  - vehicular delay and level-of-service criteria and/or
  - volume-to-capacity criteria

  As part of the operations analysis, pedestrian operations should be analyzed when deciding to install a right-turn lane. The projected operational impacts on pedestrians should be considered in the decision to install a right-turn lane.

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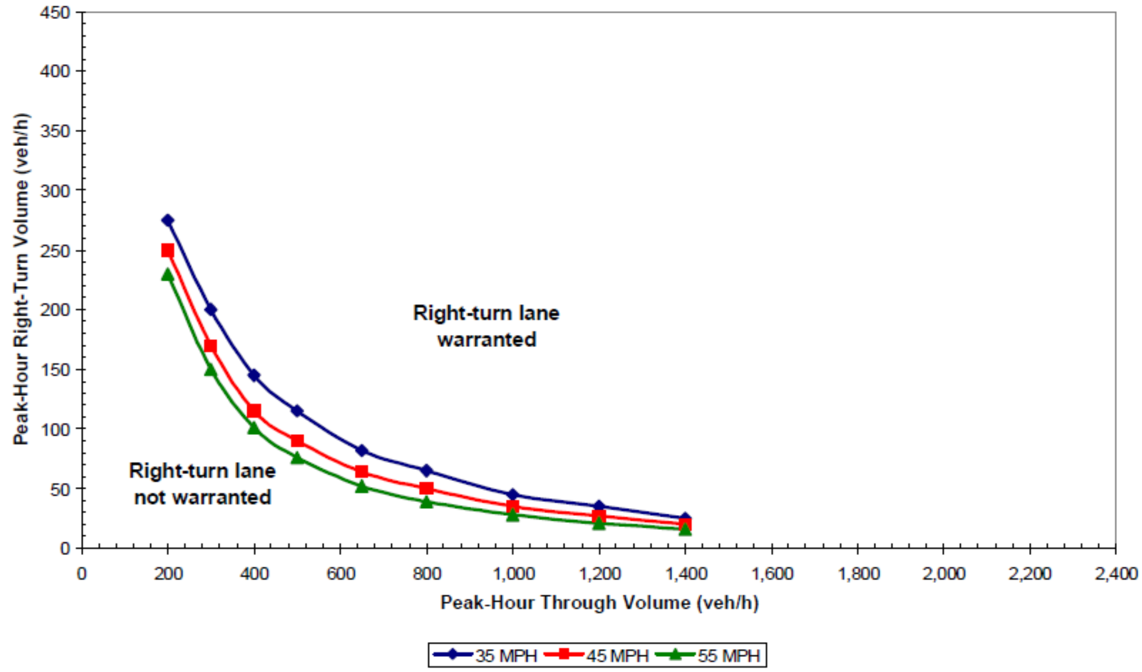
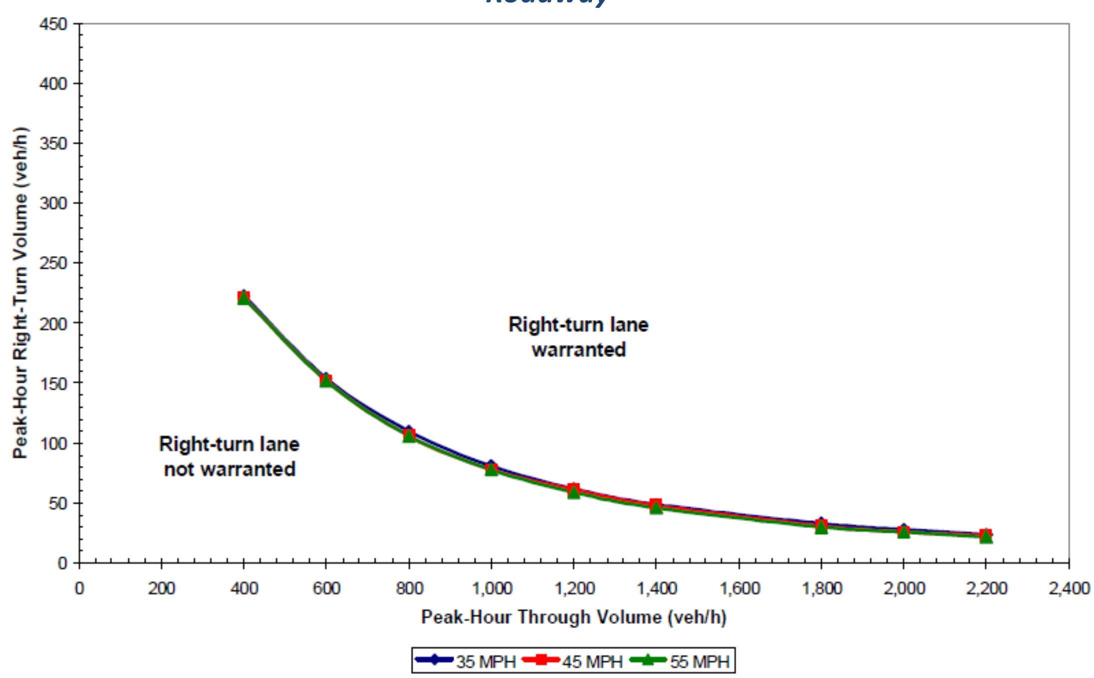
Figure 12-4: Right-Turn Lane Warrant Curves for 4-Leg Unsignalized Intersection on 2-Lane Roadway*



Source: *NCHRP Project 3-72: Lane Widths, Channelized Right-Turns, and Right-Turn Deceleration Lanes in Urban and Suburban Areas, Final Report*, August 2006, Figure 18, page 107.

*This could be a 4-leg intersection of two roadways, or a 4-leg intersection formed by two driveways aligned on opposite sides of a roadway.

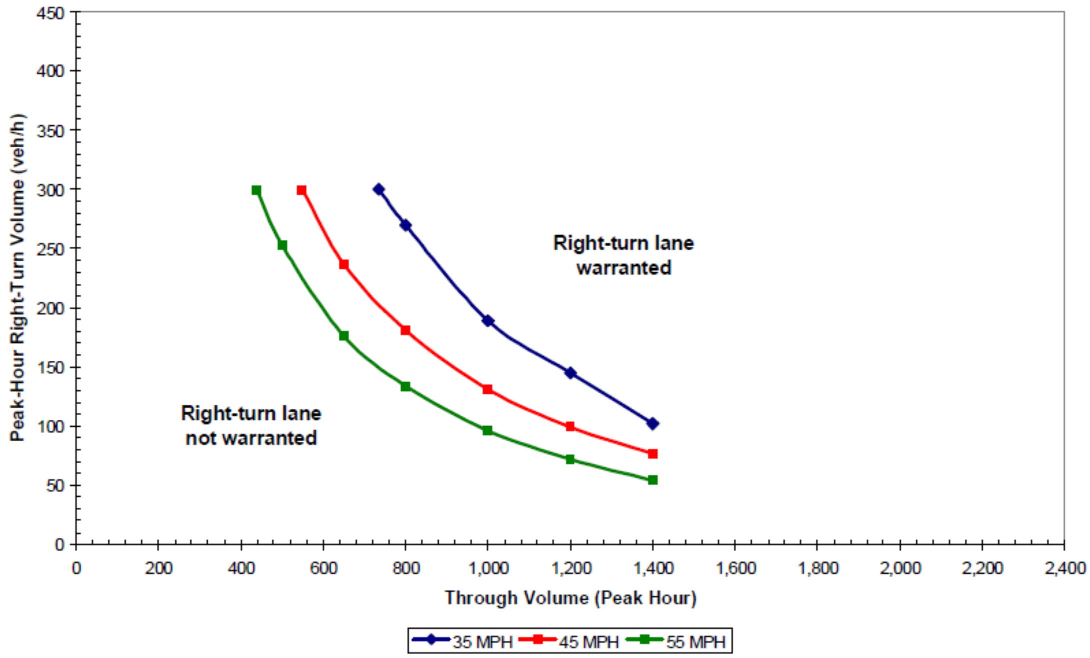
Figure 12-5: Right-Turn Lane Warrant Curves for 4-Leg Unsignalized Intersection on 4-Lane Roadway*



Source: *NCHRP Project 3-72: Lane Widths, Channelized Right-Turns, and Right-Turn Deceleration Lanes in Urban and Suburban Areas, Final Report*, August 2006, Figure 19, page 107.

*This could be a 4-leg intersection of two roadways, or a 4-leg intersection formed by two driveways aligned on opposite sides of a roadway.

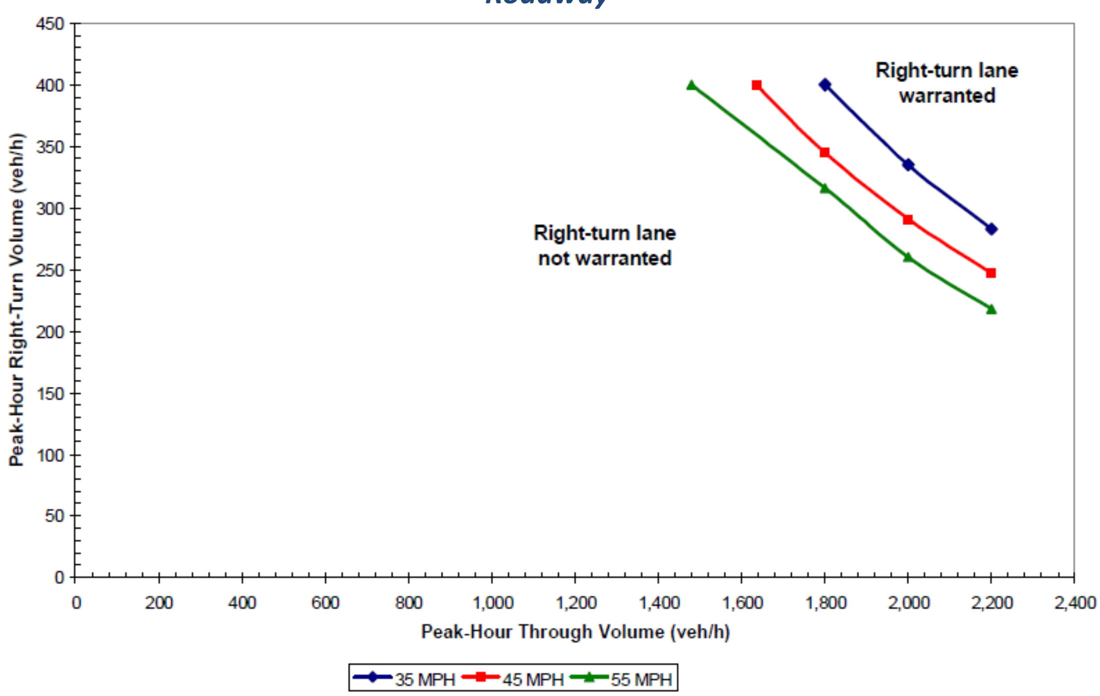
Figure 12-6: Right-Turn Lane Warrant Curves for 3-Leg Unsignalized Intersection on 2-Lane Roadway*



Source: *NCHRP Project 3-72: Lane Widths, Channelized Right-Turns, and Right-Turn Deceleration Lanes in Urban and Suburban Areas, Final Report*, August 2006, Figure 20, page 108.

*This could be a 3-leg intersection of two roadways, or a 3-leg intersection formed by a driveway intersecting a roadway.

Figure 12-7: Right-Turn Lane Warrant Curves for 3-Leg Unsignalized Intersection on 4-Lane Roadway*



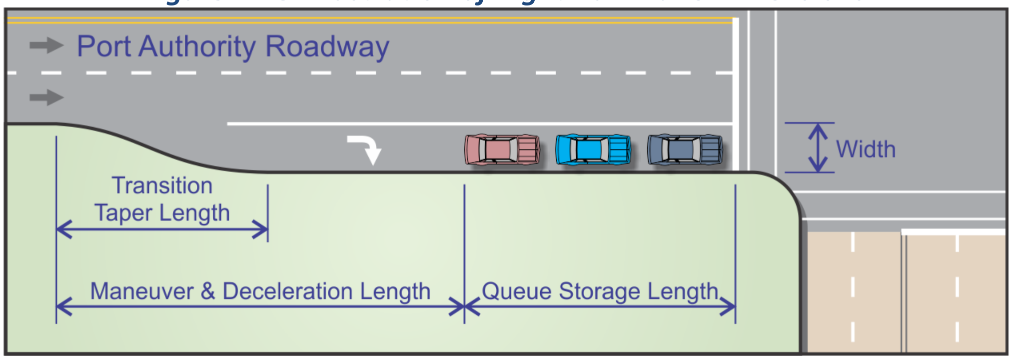
Source: *NCHRP Project 3-72: Lane Widths, Channelized Right-Turns, and Right-Turn Deceleration Lanes in Urban and Suburban Areas, Final Report*, August 2006, Figure 21, page 108.

*This could be a 3-leg intersection of two roadways, or a 3-leg intersection formed by a driveway intersecting a roadway.

12.3.2 Right-Turn Lane Design Guidelines

Once a decision to install a right-turn lane has been made, a variety of other decisions should be made relative to the design of the right-turn lane, including its width, queue storage length, and taper. The following design guidance applies to right-turn lanes on all Port Authority roadways (see *Figure 12-8* for an illustration of the right-turn lane dimensions):

Figure 12-8: Illustration of Right-Turn Lane Dimensions



- The desirable width of a right-turn lane should be 12 feet.
- The total length of the right-turn lane should be designed to include: 1) the transition taper length, 2) vehicle maneuver and deceleration length, and 3) vehicle queue storage length. These distances shall be determined as follows, based on the illustration in *Figure 12-8*:
  - The length of the transition taper for right-turn lanes should be based on the approach speed and width of the right-turn lane in accordance with the design guidance in AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011* (pp. 9-127 to 9-130), or superseding edition. As per AASHTO, a taper rate of 8:1 should be used for design speeds up to 30 mph and a taper rate of 15:1 for design speeds exceeding 30 mph.
  - The desirable maneuver and deceleration length distances are given in *Table 12-1*. The desirable maneuver and deceleration length is based on the posted speed and ranges from 90 feet (at a posted speed of 20 mph) to 425 feet (at a posted speed of 50 mph).

Table 12-1: Desirable Maneuver and Deceleration Length

Posted Speed (mph)[1]	**Maneuver and Deceleration Length** (feet)
20	90
25	110
30	160
35	215
40	275
45	345
50	425

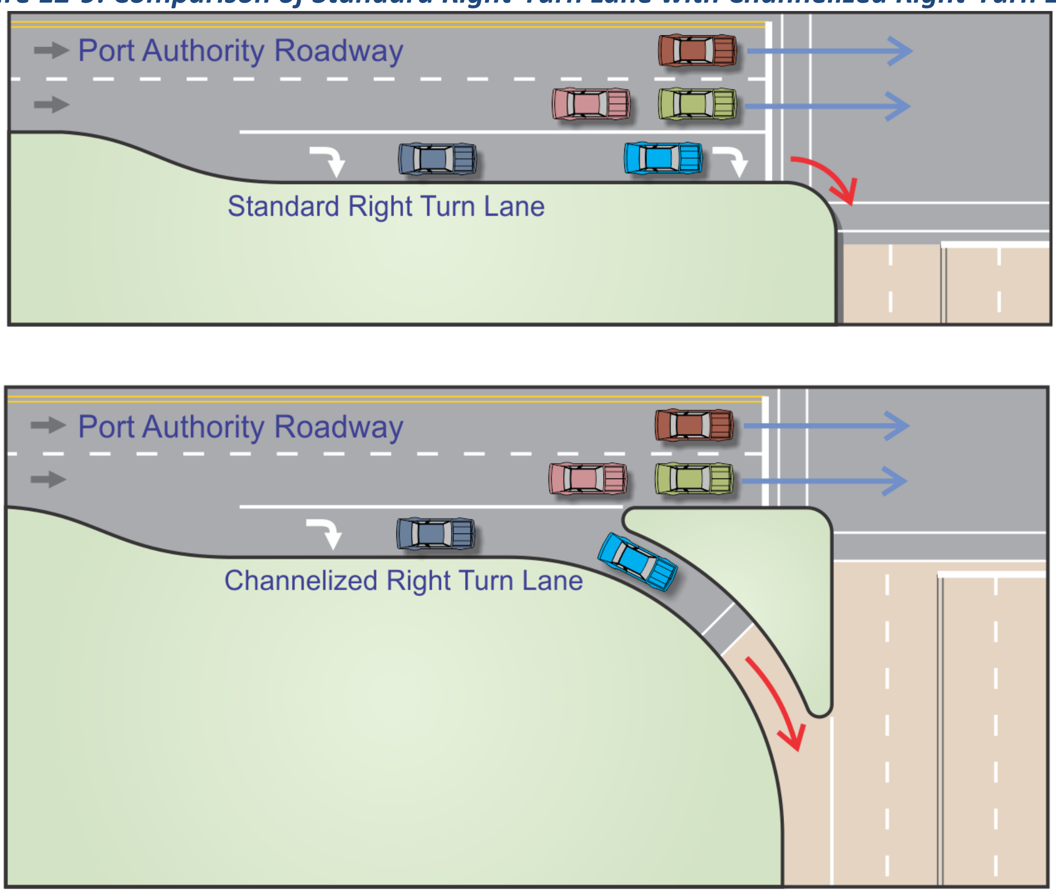
Source: Adapted from Stover, V.G. and F.J. Koepke, *Transportation and Land Development, 2nd Edition*, 2002, Table 5-13, page 5-43.

1: The 85th percentile speed may be used in place of the posted speed if an engineering study that supports the use of the 85th percentile speed over the posted speed is completed and approved by Port Authority Traffic Engineering.

  - The desirable queue storage length should equal the 95th percentile queue length[43]. The queue storage length should be adjusted to account for the lengths of the various vehicles in the traffic stream (i.e., passenger cars, single-unit trucks, tractor-trailers, etc.).

- A channelization island, as shown in *Figure 12-9*, may be used to accommodate free-flow right-turns. A channelized right-turn lane accommodates higher turning speeds, reduces vehicular delays, and adds greater capacity to the intersection than a standard right-turn lane. It should be noted that although a channelization island provides a refuge for pedestrians, the free-flowing right-turning vehicles conflict with pedestrians crossing the right-turn lane. Also, as shown in *Figure 12-9*, the channelized right-turn lane needs more physical space than a standard right-turn lane. The trade-offs should be considered when deciding whether or not to install a channelized right-turn lane. In general, a standard right-turn lane may be preferable in developed areas.

Figure 12-9: Comparison of Standard Right-Turn Lane with Channelized Right-Turn Lane



[43] Most traffic engineering software packages (e.g., HCS, SYNCHRO) calculate 95th percentile queue lengths as one of their output parameters.

CHAPTER 13: PROPERTY ACCESS STRATEGIES

13.1 Overview

In addition to the specific guidelines for access location and design described in the preceding chapters of these *Guidelines*, the design team should consider various strategies to provide for sufficient property access. These strategies include providing access through use of the following:

- secondary roadways[44]
- shared driveways and cross-access between leaseholds
- frontage roads

Each of these strategies is addressed in this chapter and should be considered before seeking a driveway on the primary roadway (*Chapter 5* and *Chapter 6*) or a design exception (*Chapter 14*). The intent of each strategy is to provide *reasonable access* for a particular property, or properties, such that the resulting access configuration conforms to the access management guidelines described in this document. For purposes of these *Guidelines*, *reasonable access* for the strategies above is defined as having the following characteristics:

1) The access is provided via a *parallel or perpendicular roadway*, *easement*, *shared driveway*, or *frontage road*.

2) The access is *designed and located to sufficiently support the volume and type of traffic* to and from the business or use. This means:

    a. Roadways, intersections, and driveways along the route accommodate the size and types of vehicles expected, as well as the anticipated volume of traffic.

    b. Pavement strength along the route is sufficient to accommodate the weight and volume of the anticipated traffic.

3) The access is *convenient*, as indicated by the access fitting with the site layout, aligning properly with the site's traffic circulation aisles, and properly serving the site's internal uses (e.g., parking lots, loading areas, security booths, etc.).

4) The access route is reasonably *direct*, as indicated by the route being relatively straight with a limited number of route choices along the path for the driver.

5) The access route provides a *well-marked* means for reaching the site and returning to the surrounding roadway network. This means signs are provided at key decision points along the route to direct motorists between the roadway and the site.

6) The access provisions for pedestrians and bicyclists involve *logical and direct* paths that are well connected with the street system.

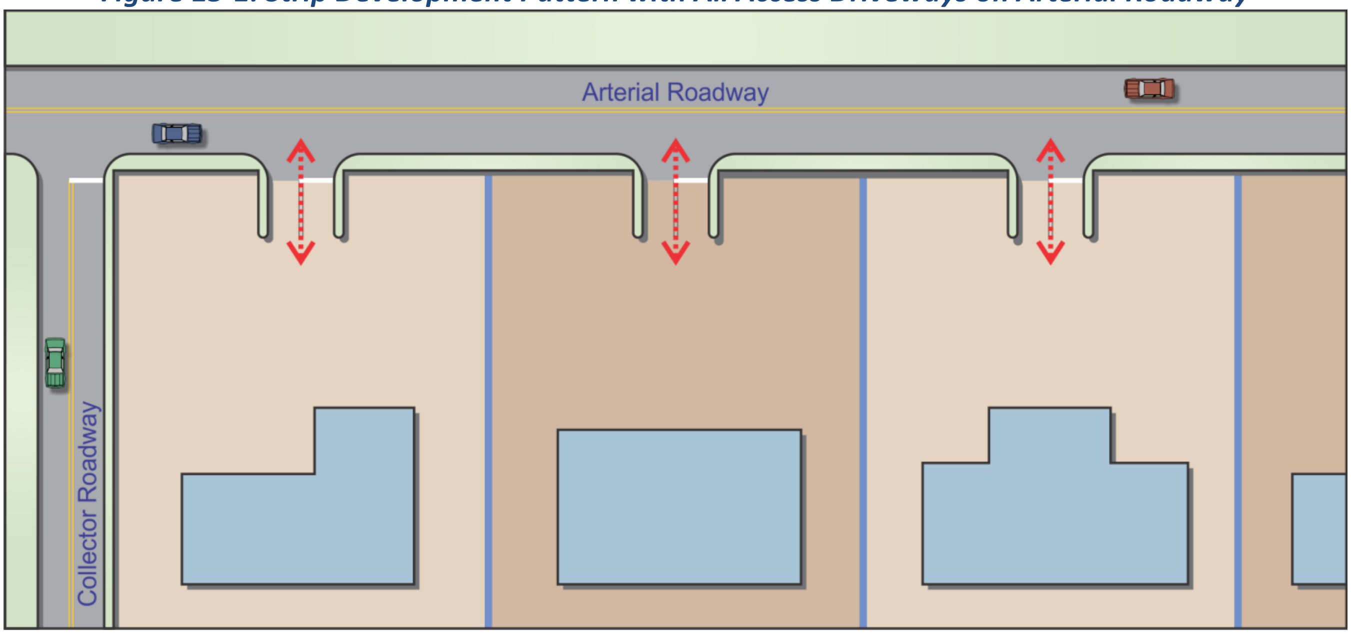
[44] As defined here, a "secondary roadway" is one that has a lower access classification than the intersecting primary roadway (see *Chapter 3*, Table 3-1).

Implementing the strategies cited above may involve several separate but coordinated actions. Further, these strategies may have implications on access to and from adjacent properties and on traffic circulation patterns on the surrounding roadway network.

13.2 Access via Lower Classification Roadways

Historically (i.e., from the 1950s through the 1990s), development has often been focused in "strips" along arterials and other higher classification roadways. These strip development patterns result in driveways being located exclusively along the arterial (see *Figure 13-1*). As a result, the arterial is used as the sole access roadway for abutting properties, and access opportunities provided by the local and collector street networks are not used. Under these circumstances, the short spacing between driveways along the arterial leads to a greater number of conflict points, increasing the potential for crashes, decreasing the operating speeds for motor vehicle traffic, and adding to the level of congestion along the arterial. The resulting conflicts between higher-speed traffic and turning vehicles, bicycles, and pedestrians can lead to crashes.

Figure 13-1: Strip Development Pattern with All Access Driveways on Arterial Roadway



This pattern can be changed by promoting the development of a connected network of intersecting and parallel roads that can accommodate access for abutting properties (see *Figure 13-2*). Such an arrangement improves the connectivity of the built environment and transfers some travel demand from arterial roadways to local and collector roadways that are, by definition, better suited to accommodate access. This arrangement also provides for improved connectivity for pedestrians and bicyclists, encouraging the use of those modes for short-distance trips. Local and collectors roads can also be designed to connect to other existing, proposed, and planned roadways in the area. Note that, as shown in *Figures 13-1* and *13-2*, the change in driveway locations may involve changing the layout of the buildings on individual sites, though this is typically not a significant concern where redevelopment is occurring or in newly-developed areas.

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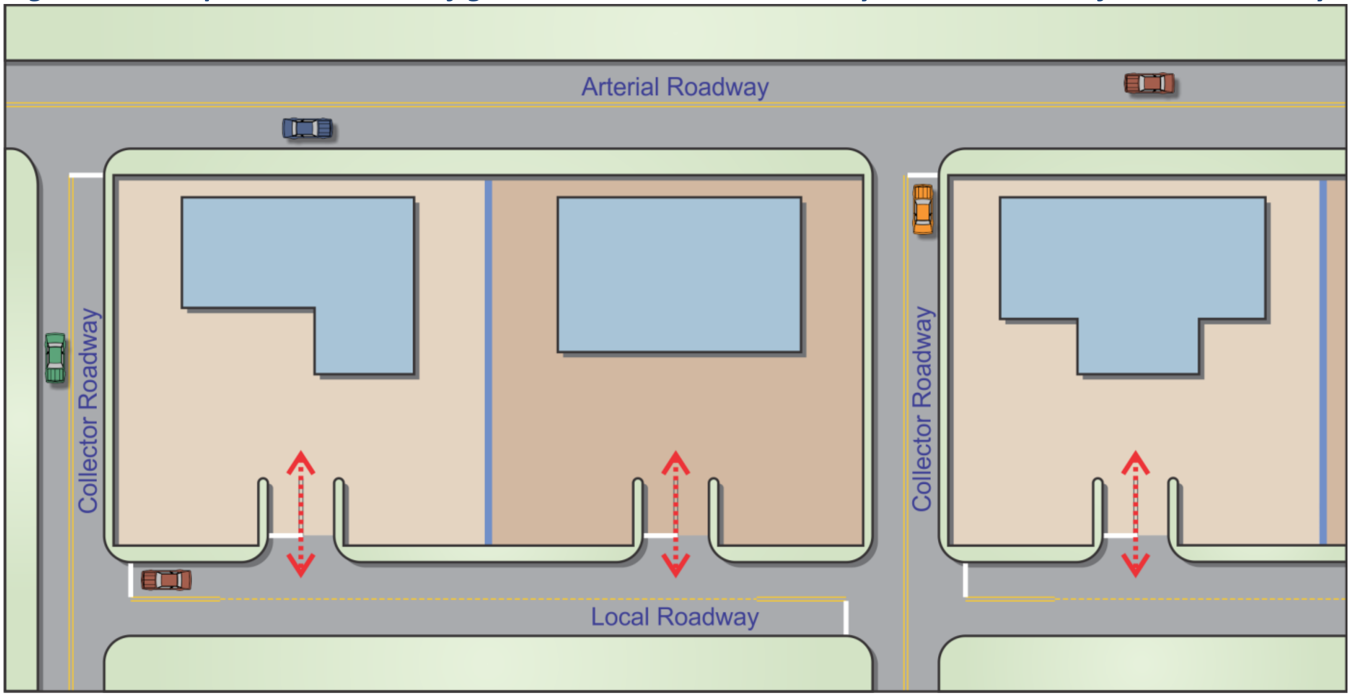
Figure 13-2: Improved Access Configuration with Access Driveways on Lower Classification Roadways

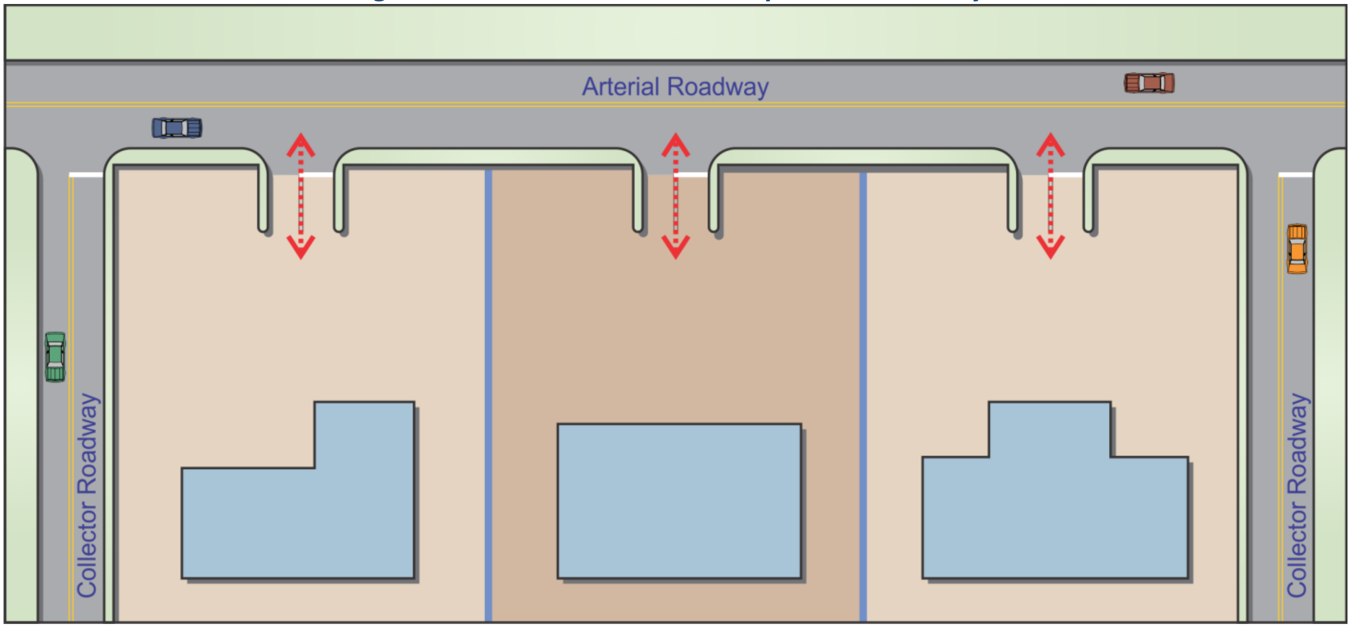


13.3 Shared Access Driveways and Cross-Access between Leaseholds

Effective access management master planning promotes the implementation of shared-access driveways and cross-access easements between (compatible) tenant leaseholds, where possible, which allow pedestrians and vehicles to circulate between leaseholds without reentering the abutting roadway. Where security requirements allow, adjacent tenants located along higher classification roadways (e.g., arterials and collectors) should be encouraged to share access. The sharing of access driveways improves roadway safety and operations by reducing the number of conflict points and separating conflict points along these roadways. The longer spacing between access driveways also facilitates the provision of left-turn and right-turn lanes. In addition, smoother traffic flow on the abutting street helps to reduce the propensity for vehicular crashes and increase egress capacity. Furthermore, cross-access connections between adjacent developments can improve convenience by facilitating vehicle and pedestrian circulation between leaseholds. This helps reduce demand on the higher classification roadways by eliminating the need for vehicles to circulate on those roadways when moving from one leasehold to another.

Figure 13-3 shows an undesirable condition whereby three leaseholds each have an access driveway to the arterial roadway. This configuration leads to closely-spaced driveways along the arterial, in addition to the local street intersections.

Figure 13-3: Leaseholds with Separate Driveways



In contrast, *Figure 13-4* shows the same three leaseholds under an improved access configuration whereby shared access driveways serve adjacent leaseholds, resulting in a reduction in the number of access driveways (and associated conflict points) along the arterial roadway.

Figure 13-4: Improved Access Configuration with Shared Driveway Access

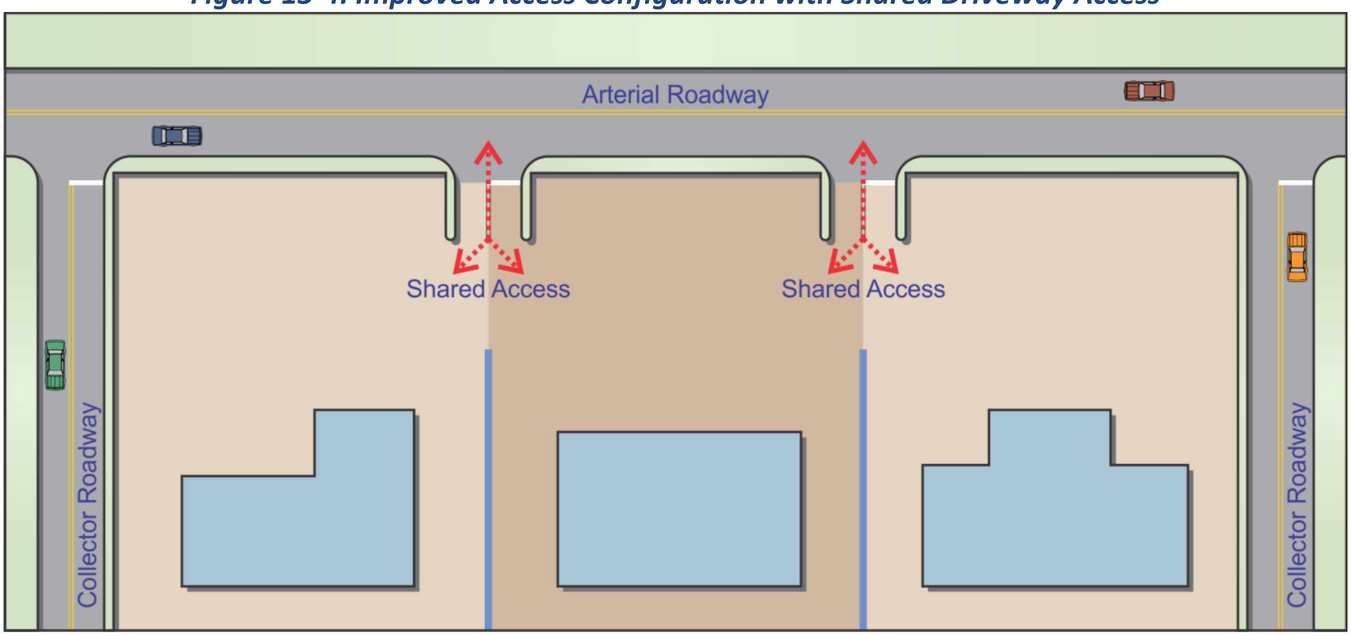


Figure 13-5 shows the same three leaseholds under another improved access configuration: one driveway is provided on the arterial roadway, located to maximize access spacing, and direct access is provided via the two intersecting local streets. Cross-access easements would be established between leaseholds to allow travel among the three leaseholds and the two intersecting local streets without the need to use the arterial.

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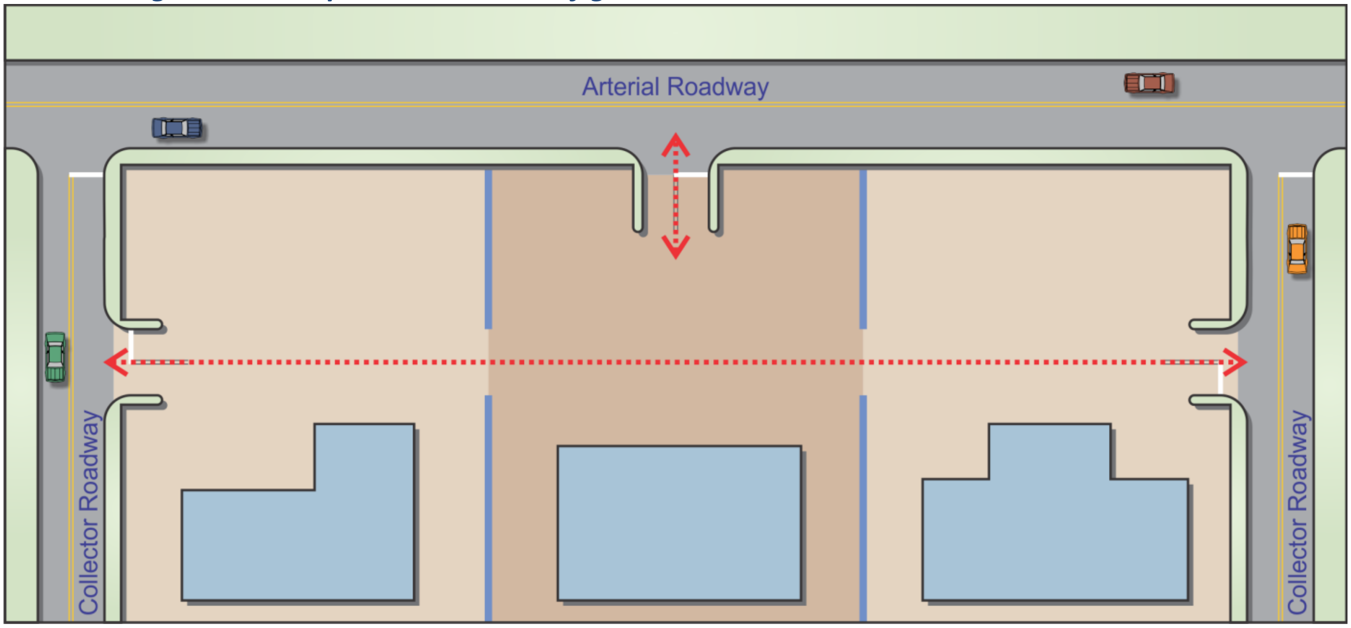
Figure 13-5: Improved Access Configuration with Cross-Access between Leaseholds

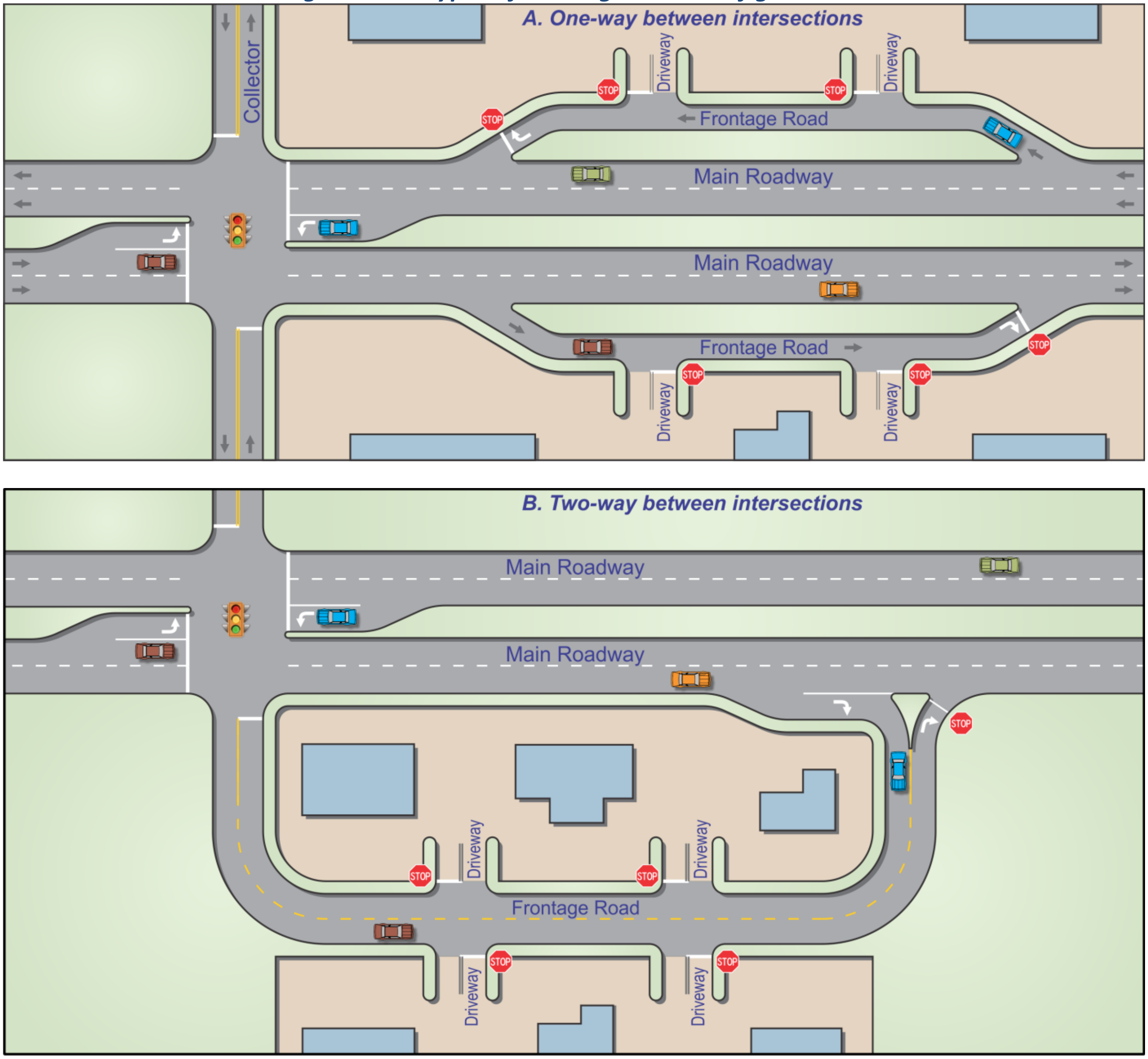


Cross-access (also known as inter-parcel connections) and/or shared access configurations — such as those illustrated in *Figures 13-4* and *13-5* — should be considered in redeveloping areas and newly developed areas. Having a unified transportation master plan and/or sub-area plans for the area, which are then implemented when development or redevelopment opportunities arise, help achieve access management objectives. See *Section 2.4.3* for a discussion of transportation master plans and *Section 2.4.4* for a discussion of sub-area plans.

13.4 Frontage Roads

A frontage road is an access roadway that is generally aligned parallel to a main roadway and is located between the right-of-way of the main roadway and the front building setback line. Frontage roads are used as an access management technique to provide direct access to properties and segregate through traffic from local access-related traffic. This protects the through traffic lanes from conflicts and delays, as well as reducing the frequency and severity of conflicts along the main roadway. In addition, the resulting increase in spacing between intersections along the main roadway facilitates the design of auxiliary lanes for deceleration and acceleration, further improving traffic safety and operations. *Figure 13-6* illustrates two types of frontage road configurations.

Figure 13-6: Types of Frontage Road Configurations



Frontage roads should be designed carefully to avoid escalating conflicts at their junctions with the main roadway and increasing delays on the intersecting roads. The following guidelines should be considered when installing frontage roads:

- Especially under retrofit situations, frontage roads should operate in one direction and should enter or leave the mainline lanes as merging or diverging movements (see *Figure 13-6A*).
- On-street parking and pedestrian and bicycle movements to and from the area served by the frontage road should be accommodated along the frontage road, rather than along the main roadway.

An alternate frontage road configuration – sometimes referred to as a "reverse frontage road" or a "backage road"– is illustrated in *Figure 13-7*. In this configuration, the one-way "frontage" roads are constructed *behind* the properties that front the main roadway. Direct property access can be provided to abutting properties along

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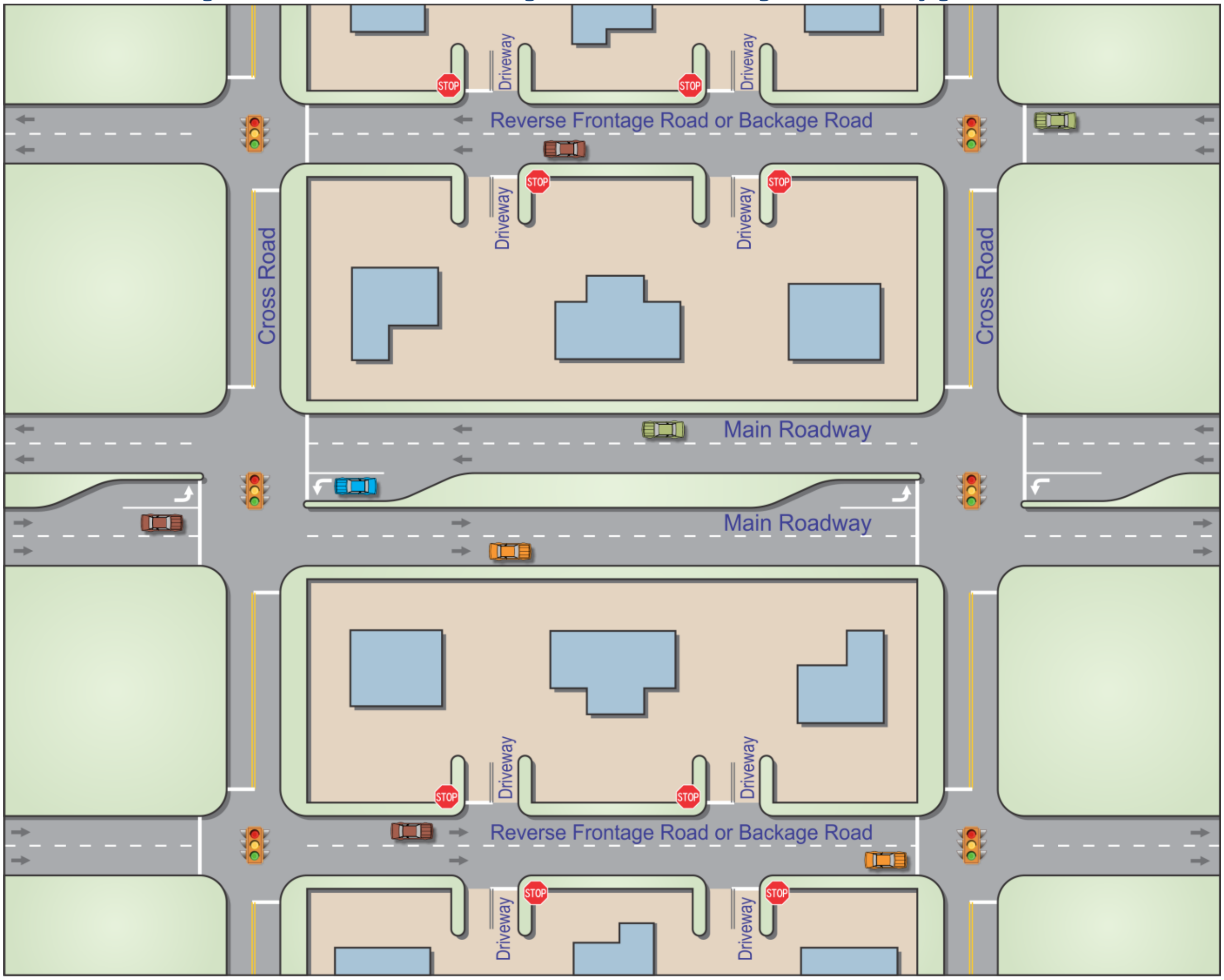
both sides of the reverse frontage road, eliminating driveways along the main roadway entirely.

Figure 13-7: "Reverse Frontage Road" or "Backage Road" Configuration



As shown in *Figure 13-7*, connections between the main roadway and the reverse frontage roads occur via intersecting cross roads. The distance along the cross road between the intersection with the reverse frontage road and the intersection with the main roadway – the separation distance – should be established to provide sufficient vehicle queue storage for cross road traffic between the reverse frontage roads and the main roadway. The following desirable guidelines apply under these circumstances:

- The desirable separation distance is 300 feet. This dimension provides queue storage space for vehicles on the approaches to the reverse frontage roads and enables turning movements to be made from the main roadway onto the cross roads without disrupting traffic flow on the main roadway. Even greater distances may be needed to provide sufficient left-turn storage on the cross road and to separate operations between an intersection on the main roadway and an adjacent intersection on the reverse frontage road.

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CHAPTER 14: DESIGN EXCEPTIONS

14.1 Overview

The access management guidelines described in this document are intended to promote safe and efficient access and mobility along roadways at Port Authority facilities. The Port Authority strives to maintain the desirable balance between mobility on Port Authority roadways and access to those roadways, with sensitivity to the needs of the agency's tenants. These goals are consistent with the agency's policy objectives as well as other factors such as environmental constraints and the objectives of neighboring agencies. Tenants should work with Port Authority Engineering to identify access solutions that meet the guidelines described in this document to provide reasonable access. However, where the guidelines cannot be met and a degree of greater flexibility is needed, a "design exception" ─ a deviation from the access management guidelines authorized by the Port Authority ─ may be requested.

Design exceptions provide the Port Authority with the flexibility necessary to create reasonable solutions in unique situations, when there are special considerations such as conflicts between competing policy goals and environmental constraints. The ultimate goal is to reach a solution that the Port Authority can approve for the specific location and that all involved parties can "live with."

For these reasons, establishing a fair, consistent, and systematic process to address design exceptions is a key element of the Port Authority's approach to access management. This chapter presents the design exception procedure established for the Port Authority and the general criteria for the approval of design exceptions. Two examples illustrating the application of the design exception process and criteria are also provided.

14.2 General Design Exception Approval Criteria

When conditions warrant, a design exception may be granted by the Port Authority. A design exception may be approved by the Port Authority when it can be documented that a lesser design value is the best practical alternative. Given the added time and associated costs involved when pursuing an access management design exception, tenants should explore all possible alternatives prior to pursuing a design exception and work with Port Authority Engineering to understand the general circumstances under which a design exception would be approved. Port Authority Engineering will only approve a design exception when all reasonable alternatives[45] that meet the access management guidelines have been evaluated and determined to be infeasible, and the design exception would not result in a condition that would jeopardize the safety of the public or have a significant adverse impact on traffic operations or safety.

14.3 Design Exception Procedure

A request to the Chief Engineer for the relevant discipline shall be submitted. The reason for the design exception should be clearly stated and all supporting and necessary documentation to substantiate the design exception should be included.

Figure 14-1 is a conceptual illustration of when a design exception is needed at the Port Authority.

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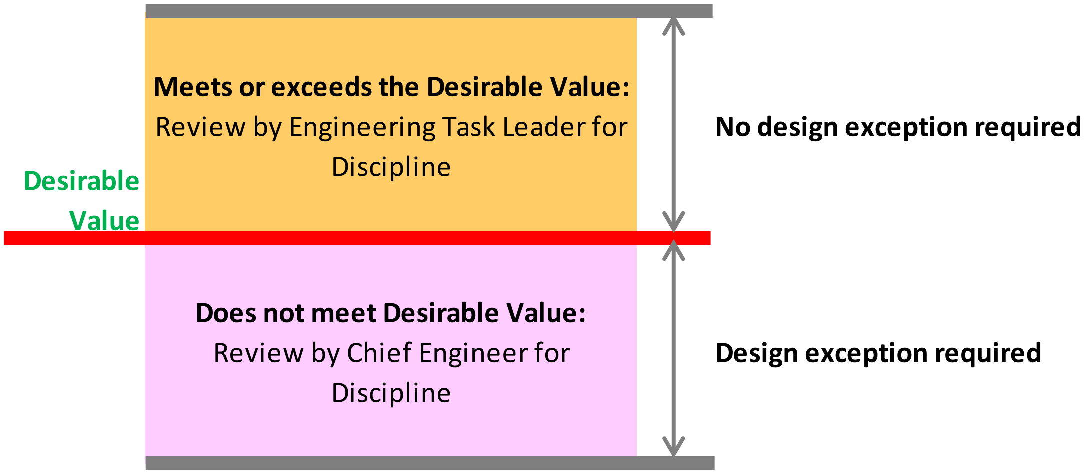
[45] Including redrawing the leasehold boundaries.

Figure 14-1: Conceptual Illustration of When an Access Management Design Exception is Needed



The design exception procedure at the Port Authority is as follows:

- If the desirable value stated in the guidelines is met or exceeded, a review by the Port Authority Engineering task leader for the relevant discipline is needed, but no design exception is needed.
- If the desirable value cannot be met, an access management design exception is needed for the associated value as stated in the guidelines. Access management design exceptions are reviewed by the Port Authority Chief Engineer for the relevant discipline. In most instances, the relevant lead discipline is Port Authority Traffic Engineering, but the discipline may be Port Authority Civil Engineering, Electrical Engineering, or other disciplines, based on the nature of the design exception needed. (See *Table 2-1* for the proper Port Authority point-of-contact within the Engineering Department.)

14.4 Examples

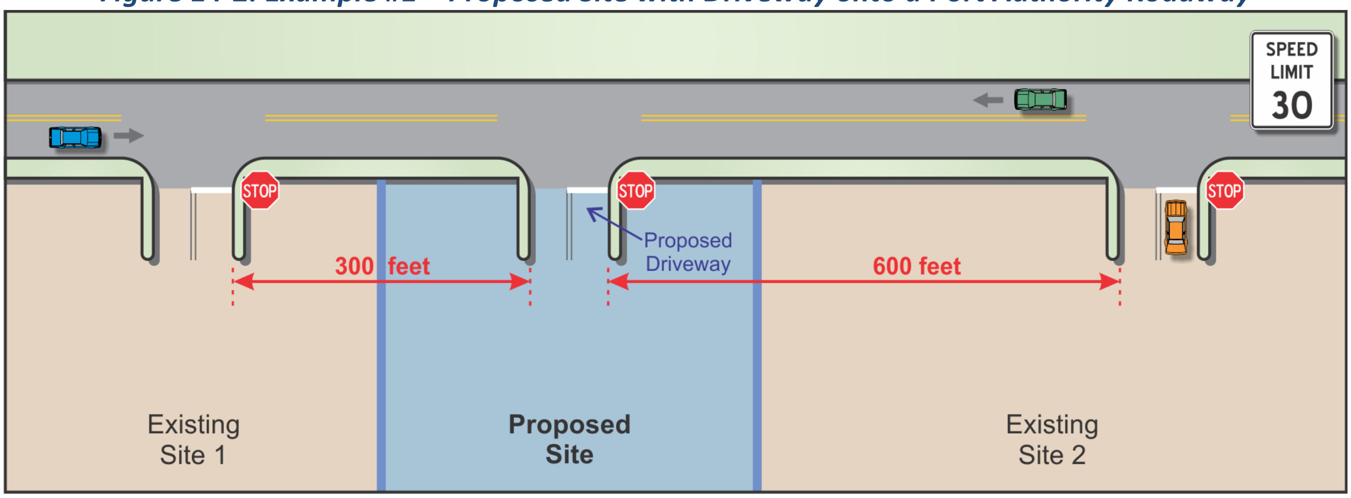
The following two examples illustrate the application of the design exception procedures to specific access management guidelines described in this document.

14.4.1 Example #1: Unsignalized Driveway Spacing

Given: An undivided Port Authority roadway with a collector access classification and a posted speed of 30 mph. A stop-controlled driveway is proposed to be located between two existing stop-controlled driveways, as shown in *Figure 14-2*.

Problem: Determine if the proposed driveway location meets the unsignalized driveway spacing guidelines given in *Chapter 5*.

Figure 14-2: Example #1 – Proposed Site with Driveway onto a Port Authority Roadway



Solution:

- Use *Table 5-1* to identify the desirable driveway spacing distance as shown below.

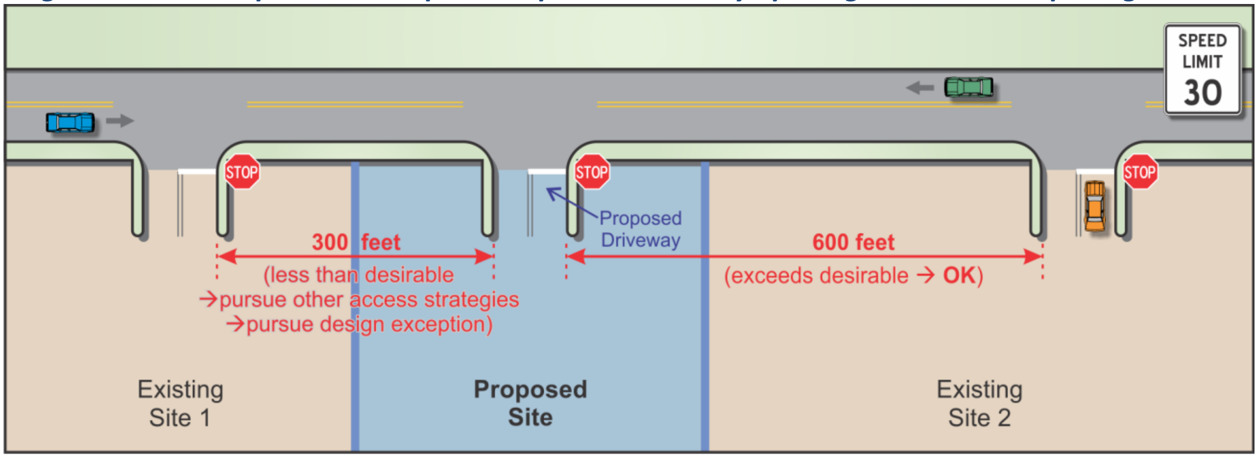
Posted Speed (mph)	Desirable Driveway Spacing	
	Undivided Roadways (feet)	Divided Roadways (feet)
20	260	245
25	370	340
30	**500**	450
35	640	570

As shown in *Table 5-1*:

Desirable driveway spacing distance = 500 feet

- Compare the desirable spacing distance to the distances between the proposed driveway and the two existing driveways from the site plan (see *Figure 14-3*).

Figure 14-3: Example #1 – Compare Proposed Driveway Spacing to Desirable Spacing



The distance between the proposed driveway and the existing driveway for Site 2 (600 feet) exceeds the desirable spacing guideline (500 feet); therefore, according to *Figure 14-1*, no design exception is needed for the proposed spacing to Site 2.

The distance between the proposed driveway and the existing driveway for Site 1 (300 feet) does not exceed the desirable spacing guideline (500 feet). Therefore, further analysis is needed, relative to the spacing between the proposed driveway and the existing driveway for Site 1. Applicable questions to ask at this point include the following:

1) Would any of the property access strategies presented in Chapter 13 be applicable to the subject site?

2) Would a design exception be needed for the proposed access driveway?

- Consideration of property access strategies in *Chapter 13* would involve "zooming out" from the initial area shown in *Figure 14-3* to consider other ways of providing access to the proposed site. Because this is an example problem to illustrate the design exception process, the strategies in *Chapter 13* will not be provided here.

- Because the spacing between the proposed driveway and the existing driveway at Site 1 (300 feet) is less than the desirable spacing (500 feet), a design exception is needed (refer to *Figure 14-1*) if no other access solution can be identified. Approval from the Port Authority Chief Traffic Engineer is needed. As part of the Chief's review, it is expected that he/she will ask to review the investigations of the property access strategies described in *Chapter 13* (that were not provided in this solution).

14.4.2 Example #2: Access in the Vicinity of Interchanges

Given:

- A new traffic signal is proposed on a four-lane divided Port Authority roadway with a posted speed of 40 mph (see *Figure 14-4*).
- The new traffic signal is proposed to be located 1,000 feet downstream of an existing interchange off-ramp.

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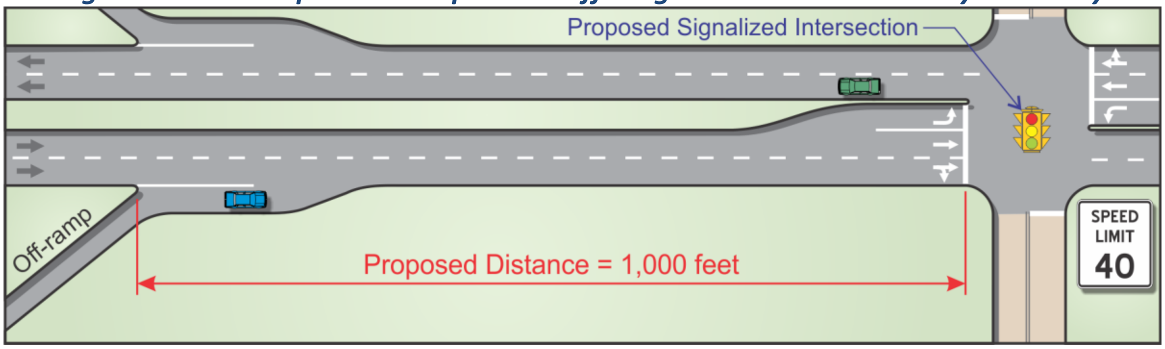
- No other traffic signals are located along the roadway.

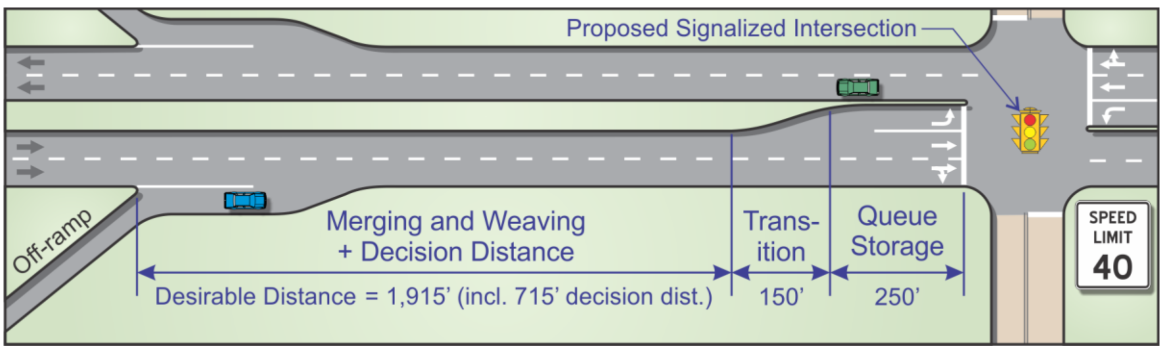
Problem: Determine if the proposed intersection meets the guidelines for access in the vicinity of interchanges given in *Chapter 8*.

Figure 14-4: Example #2 – Proposed Traffic Signal on a Port Authority Roadway



Solution:

- Calculate the desirable spacing distance (see procedures in *Chapter 8* for access in the vicinity of interchanges).



Desirable spacing distance = 2,315 feet

- Compare the proposed spacing (1,000 feet) to the desirable spacing distance (2,315 feet).
- Because the spacing between the proposed traffic signal and the interchange off-ramp (1,000 feet) is less than the desirable spacing (2,315 feet), a design exception from Port Authority Traffic Engineering would be needed. The design exception would need approval from the Port Authority Chief Traffic Engineer (refer to *Figure 14-1*).

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REFERENCES

The following documents, with the specific editions noted below, were consulted in the preparation of these *Guidelines*:

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GLOSSARY

The following words and phrases, when used in these *Guidelines*, have the following meanings:

- **85th Percentile Queue Length:** The distance that would not be exceeded by a queue of vehicles 85 percent of the time during the analysis period.
- **95th Percentile Queue Length:** The distance that would not be exceeded by a queue of vehicles 95 percent of the time during the analysis period.
- **Access Classification System (ACS):** A hierarchy of access categories that forms the basis for the application of access management to all roadways. Each access category sets forth criteria governing the access-related standards and characteristics for corresponding roadways. These access categories ultimately define where access can be allowed between the roadway system and abutting properties, and where it should be denied or discouraged.
- **Access Management:** The coordinated planning, regulation, and design of access between roadways and land development. It involves the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway, as well as roadway design applications that affect access, such as median treatments and auxiliary lanes, and the appropriate separation of traffic signals.
- **Access Window:** The distance along the lateral length of a roadway – located outside the functional area of adjacent intersections – where a driveway may be located. The access window is identified by determining the upstream and downstream corner clearance distances at the adjacent intersections. The longer the access window, the more flexibility exists with respect to locating the driveway along the roadway.
- **Arterial:** An interrupted-flow roadway primarily used for the movement of through traffic. Access to abutting land uses is subordinate to through traffic movement. Arterials are distinct from Principal Arterials, which serve a high percentage of trucks.
- **Auxiliary Lane:** An exclusive right-turn or left-turn lane.
- **Backage Road:** An interrupted-flow roadway constructed at the rear of properties that front a major roadway for purposes of providing access to those properties. Also known as a **Reverse Frontage Road**.
- **Bandwidth:** The amount of time available, in seconds, for vehicles to travel through a series of traffic signals along a corridor at a specific progression speed. Bandwidth is a quantitative measurement of the through-traffic capacity of a signal progression system: the greater the bandwidth, the higher the capacity for progressing through-traffic along the corridor. The length of the bandwidth is the time elapsed between the passing of the first vehicle and the last vehicle that moves without impedance through a traffic signal system at the progression speed. Bandwidth may also be expressed as a percentage of the cycle length. For example, a 40-second green band along a corridor operating at cycle lengths of 80 seconds can be expressed as a "bandwidth of 50 percent."
- **Clear Zone:** The total roadside border area, starting at the edge of the traveled way, available for use by errant vehicles. This area may consist of a shoulder, a recoverable slope, and/or a clear run-out area. The desired width is dependent upon traffic volumes, speeds, and roadside geometry.
- **Collector Road:** An interrupted-flow roadway that provides both land access and traffic circulation functions by collecting traffic to/from local and private roadways and channelizing it to/from arterial roadways.
- **Complete Street:** A roadway that is comfortable, convenient, and safe for travel by motorists, pedestrians, bicyclists, and transit users of all ages and abilities, as well as sensitive to the context of its surrounding land uses and environment.
- **Conflict Point:** An area where intersecting traffic merges, diverges, or crosses.

- **Corner Clearance:** The distance from an intersection to the nearest access driveway.
- **Cross Slope:** The slope (or grade) of a roadway perpendicular to the direction of travel.
- **Crosswalk:** A crosswalk may be “marked” or “unmarked.” A “marked crosswalk” is defined as any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color. An “unmarked crosswalk” is defined as that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line.
- **Curb Return Radius:** A circular pavement transition at the entrance of a driveway that facilitates turning movements.
- **Design Exception:** A deviation from the access management guidelines authorized by the Port Authority.
- **Developed Area:** An urbanized area characterized by one or more of the following features: (a) dense roadside development, (b) a substantial number of existing intersecting roadways, (c) limited right-of-way available for roadway improvements, (d) existing environmental and/or topographic constraints, and/or (e) significant pedestrian or transit considerations.
- **Developing Area:** An area that is (or will be) undergoing changes related to roadside development activity. These areas are typically characterized by one or more of the following features: (a) roadside development that is planned, imminent, or already taking place, (b) a growing number of driveways and intersecting roadways, (c) increasing pedestrian activity, and/or (d) a need to consider transit.
- **Divided Roadway:** A roadway on which traffic traveling in opposite directions is physically separated by a non-traversable (i.e., raised) median.
- **Driveway:** Any at-grade connection that provides access between a Port Authority roadway and activities or buildings on abutting properties or leaseholds.
- **Easement:** A right-of-way granted by the Port Authority to a tenant, utility company, or other party for specific and limited use of land. Within the easement area, specific tenant uses of the land may be limited or prohibited.
- **Egress:** The act of leaving or exiting a place, or the exit for vehicular traffic from abutting properties to a roadway.
- **Engineering Judgment:** The evaluation of available pertinent information and the application of appropriate principles, provisions, and practices as contained in these *Guidelines* and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device or roadway characteristic. Engineering judgment is exercised by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer in consultation with Port Authority Engineering. This consultation should be documented.
- **Engineering Study:** The comprehensive analysis and evaluation of available pertinent information and the application of appropriate principles, provisions, and practices as contained in these *Guidelines* and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device or roadway characteristic. An engineering study is performed by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. An engineering study is documented and prepared in consultation with Port Authority Engineering at the team conceptual planning meeting or subsequent coordination meetings.
- **Freeway:** A roadway designed for uninterrupted mobility and used exclusively for the movement of through traffic, without serving any direct property access function (i.e., no driveways). Access to and

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from freeways is limited to grade-separated interchanges.

- **Frontage Road:** An access roadway that generally parallels a main roadway and is located between the right-of-way of the main roadway and the front building setback line. The frontage road provides direct access to properties, segregates through-traffic from local access-related traffic (thereby protecting the through-traffic lanes from conflicts and delays), and reduces the frequency and severity of conflicts along the main roadway.
- **Functional Area (of an Intersection):** The area beyond the physical intersection of two or more roadways that comprises the decision and maneuver distance, plus any needed vehicle storage length. It is desirable that the functional area be protected by the application of corner clearance and driveway spacing guidelines.
- **Ingress:** The act of entering into a place, or the entrance for vehicular traffic into abutting properties from a roadway.
- **Intersection:** Any at-grade connection with a roadway, including the connection of two roads or the connection between a driveway and a road.
- **Local Roadway:** An interrupted-flow roadway primarily intended to provide direct access to abutting land uses and accommodate a very low level of through traffic movement. At Port Authority facilities, local roadways are generally owned, operated, and maintained by the Port Authority.
- **Loon:** An extension of the pavement adjacent to the outer travel lane of a roadway for purposes of accommodating the U-turning path of vehicles, typically trucks and other large vehicles with large turning radii.
- **Master Plan (or Transportation Master Plan):** A system-wide transportation plan for an entire Port Authority facility, prepared to accommodate projected changes in land development patterns and provide a supporting transportation system. The plan provides the framework for the consistent application of access management throughout the facility.
- **May:** Indicates a statement of practice that is a permissive condition.
- **Median:** That portion of a roadway that separates opposing traffic flows, not including two-way left-turn lanes. A median can be traversable or non-traversable.
- **Median Opening:** An opening in a non-traversable median that provides for crossing and turning traffic. A "full" median opening allows all turning movements, whereas a "partial" median opening allows only specific movements and physically prohibits all other movements.
- **Non-Traversable Median:** A physical barrier in the roadway that separates traffic traveling in opposite directions, such as a concrete barrier or curbed island. The curbed island may or may not be landscaped.
- **Open Frontage:** A property frontage that consists of a large driveway lacking a defined lane arrangement; vehicles may enter and exit the property at any point along the frontage. Open frontages do not provide positive guidance to drivers entering and leaving the property and, thus, create additional conflict points relative to a standard driveway. As such, they are undesirable and should be avoided.
- **Port Authority Redevelopment Program:** A coordinated set of capital projects that reflect a major enhancement, upgrade, and/or improvement to a specific Port Authority facility. A redevelopment program contrasts with a "state of good repair" program that involves replacement-in-kind of existing infrastructure. Examples include the "JFK 2000 Airport Redevelopment Program," the "Newark Airport Redevelopment Program" (constructed between 2000 and 2003), the "LaGuardia Terminal Building Redevelopment Program" (under planning in 2011 and 2012), the "Downtown Restoration Program" (to rebuild the World Trade Center Site after 9/11), "Newark Airport Terminal A Redevelopment Program" (under planning in 2010 – 2012), and the "Lincoln Tunnel Helix Replacement" (under planning in 2011).
- **Pathway:** A general term denoting a traveled way for pedestrians and non-motorized vehicles outside of the roadway. Pathways are physically separated from the roadway by an open space or barrier, either

within the roadway right-of-way or within an independent alignment. Pathways include shared-use paths but do not include sidewalks.

- **Positive Offset:** A lateral shift in the left-turn lane alignment to improve the ability of left-turning drivers to see oncoming traffic.
- **Principal Arterial:** An interrupted-flow roadway primarily used for the movement of through traffic. Access to abutting land uses is subordinate to through traffic movement. Principal Arterials are distinct from Arterials, which serve a lower percentage of trucks.
- **Private Road Open for Public Travel:** An interrupted-flow roadway (including any adjacent sidewalks that generally run parallel to the roadway) within the tenant leasehold boundary, but on Port Authority property, where the public is allowed to travel without access restrictions. Private roadways are primarily intended to provide direct access to abutting land uses and accommodate a very low level of through traffic movement. They are also typically designed, operated, and maintained in accordance with negotiated lease agreements.
- **Ramp Terminal:** The intersection of a freeway ramp (entrance or exit ramp) and a surface street.
- **Retrofit:** A project or action taken to improve the transportation system to correct one or more identified operational or safety deficiencies. In some cases, retrofit projects are necessary based on a lack of proactive access management planning practices over long periods of time.
- **Reverse Frontage Road:** An interrupted-flow roadway constructed at the rear of properties fronting a major roadway for purposes of providing access to those properties. Also known as a **Backage Road**.
- **Right-of-Way (ROW):** A strip of land occupied, or intended to be occupied, by a roadway, sidewalk, crosswalk, or other feature.
- **Roadside Buffer:** The area, starting at the edge of the shoulder and extending away from the roadway centerline a horizontal distance specified in *Table 10-1* of these *Guidelines*. When no shoulder is present, the roadside buffer begins at the edge of traveled way. The purpose of the roadside buffer is to provide space for placing and maintaining utilities, locating roadside guide signs, and having a recovery area for errant vehicles.
- **Shall:** Indicates a required or mandatory action.
- **Shared Access:** A single access driveway serving two or more ad**jacent propert**ies or tenant leaseholds.
- **Should:** Indicates guidance of recommended practice, with deviations allowed by the Chief Engineer of the relevant discipline.
- **Sidewalk:** That portion of a street between the curb line, or the lateral edge line of a roadway, and the adjacent tenant lease line that is paved or improved and intended for use by pedestrians.
- **Sight Distance:** The unobstructed distance along which a driver can see an object or oncoming vehicle of a specified height.
- **Sight Triangle:** A desired area of unobstructed sight distance adjacent to the approach of an intersection or driveway along a roadway. Unobstructed sight triangles are typically needed from the approach in both directions along the roadway.
- **Signal Progression:** The progressive movement of traffic, at a planned rate of speed without stopping, through adjacent signalized intersections within a traffic control system.
- **Signal Spacing:** The distance between signalized intersections along a roadway. Signal spacing is typically measured between the points of intersecting centerlines at adjacent signalized intersections.
- **Sub-Area Plan:** A plan addressing mobility and access needs for a specific area of a Port Authority facility. The sub-area may include one or more tenant leaseholds within a Port Authority facility and/or one or more roadways. Preparation of a sub-area plan helps implement access management by providing

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a framework for the consistent application of access management to accommodate potential changes in land development patterns.

- **Team Conceptual Planning Meeting:** A meeting taking place at project inception, prior to the preparation or submittal of any formal studies, reports, design drawings, or other such documents. This meeting is intended to provide an early opportunity for the PA Line Department staff, PA Engineering staff, tenants and tenant representatives, and other affected stakeholders to meet and discuss the framework for required deliverables and future coordination efforts with the PA as part of TAA projects, new leases, lease renewals, and Port Authority projects.
- **Throat Length:** The storage length available that is free of conflicts for vehicles entering and exiting a driveway. The throat length is measured from the outer edge of the traveled way of the intersecting roadway to the first point at which there are conflicting traffic movements on the subject property or leasehold served by the driveway.
- **Time-Space Diagram:** A graph on which the distance between signals and signal timing is plotted against time, and indicating the bandwidth and speed of traffic.
- **Traffic:** Pedestrians, bicyclists, motorized vehicles, streetcars, and other conveyances either singularly or together used for purposes of travel.
- **Transportation Master Plan:** See **Master Plan**.
- **Two-Way Left-Turn Lane (TWLTL):** A continuous lane located between opposing traffic streams on a roadway that provides a refuge area for vehicles to complete left-turns from both directions.
- **Undeveloped Area:** An area characterized by: (a) little to no roadside development, (b) few, if any, intersecting driveways and roadways, (c) right-of-way available for roadway improvements, and/or (d) little to no pedestrian activity.
- **Undivided Roadway:** A roadway that has no directional separator, natural or structural, to separate traffic moving in opposite directions. For example, a roadway cross-section containing a traversable median or a two-way left-turn lane are considered undivided.

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LIST OF COMMON ABBREVIATIONS

AASHTO ....American Association of State Highway and Transportation Officials

ACS..................Access Classification System

ADA.................Americans with Disabilities Act

AADT ....Annual Average Daily Traffic

ADT ....Average Daily Traffic

EWR.................Newark Liberty International Airport

FHWA..............Federal Highway Administration

HCM ....Highway Capacity Manual

HCS..................Highway Capacity Software

ITE ....Institute of Transportation Engineers

JFK...................John F. Kennedy International Airport

LGA ....LaGuardia Airport

mph ....miles per hour

MUTCD...........Manual on Uniform Traffic Control Devices for Streets and Highways

NCHRP ....National Cooperative Highway Research Program

PATH...............Port Authority Trans-Hudson

SWF ....Stewart International Airport

TAA ....Tenant Alteration Application

TCAP ....Tenant Construction and Alteration Process

TEB..................Teterboro Airport

TRB..................Transportation Research Board